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THE

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(J. A. BERLY'S).

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A SUGGESTED MODIFICATION OF TRADES UNIONISM.

A LETTER to the *Standard* of the 25th inst., a statement of Mr. Barnes published in the daily press of the 28th, and the impressions produced by the fruitless Conference lately held between employers and representatives of the Amalgamated Society of Engineers, have led us to propound a scheme, or rather the germ of what might perhaps be evolved into a practical scheme, for the future amicable settlement of trade disputes such as that which has now, for nearly six months, defied the well-meant efforts of all who have so far tried their hands at effecting a termination of the engineers' strike on terms satisfactory to both masters and men.

It will perhaps, first of all, be well to reproduce the letter to which we refer above, which reads as follows, the italics being ours:

Sir,—We are one of the firms that conceded the eight hours' day, but we are unable to admit that the men do any better in consequence. The men lose time, as before, and are as indisposed as before to work their machinery to its full capacity. A few days since one of our men persisted in working a machine at about one-twelfth of its capacity. On being remonstrated with by his foreman, he threw up his job, and threatened the foreman with personal violence.

If the unions want to justify their existence with national well-being, *they should join with employers in obtaining as great an output as possible, and should expel from their ranks all men of the sort referred to.* Were they to do this, we should then find that, instead of membership of a union being a disqualification, as at present, union men would have the preference.

We are, Sir, your obedient servants,

OXYGEN.

December 24th.

This may be followed up by the statement attributed to Mr. Barnes, that certain employers outside the Federation were not unlikely to come to the help of the engineers with a counter set of regulations, and he was himself in communication with one of these gentlemen.

"There is a feeling outside the Federation," he added, "that the terms and conditions of management which we have been asked to accept are pettifogging and unnecessarily irritating. This feeling, I have reason to believe, exists to some extent even amongst those who have subscribed to the conditions by virtue of their membership of the Federation. Two firms at least have been mentioned to me as not opposed to a set of counter proposals, and, indeed, as willing to subscribe to them."

We do not intend to refer to the two distinct ballots brought about, not by the masters, but by the trade union leaders, which are supposed to indicate the feeling of the men on strike, but will go straight to our point, which is based on the Conference. This, it is true, has plainly broken down, but again this is due solely to the action of the union. The proposal of the *St. James's Gazette*, which has throughout spoken in the true interests of the men, although they, unfortunately, can see nothing except through the eyes of their selfish and infatuated leaders, is thus briefly put:—"Let the employers suspend the lock-out notices and allow their workmen to return to work if they like, on the terms which the union has rejected. Mr. Barnes would then, we fancy, find his followers to be a rapidly-diminishing quantity."

It is possible that our contemporary's contention might come to pass, but something more definite is wanted; something which need not necessarily allow of any future labour disputes attaining to the seriousness of a general strike at all.

At the present moment more than 80,000 men of all denominations are idle. The Conference, which was composed of equal numbers of employers and labour representatives, met with the intention, at least on the part of the former, of bringing the dispute to a speedy and amicable conclusion on terms mutually satisfactory to each party.

The result, unfortunately, has not altered the situation, and things remain *in statu quo;* but had the unionist leaders been in even a moderate degree amenable to reason, or desirous of abiding by the consensus of public opinion, we should now have seen all the engineering establishments in the kingdom filled with workers as busy as bees in a hive, and holding their own against that ever-increasing dread of foreign competition, which, without a shadow of doubt, is threatening the bulk of our home industries.

Let us for a moment assume that the Conference had met and quickly settled, as everybody hoped would have been the case, the questions in dispute and under discussion.

There would then have been presented to us the object lesson of a given number of employers selected from the Federation acting in concert with an equal number of representatives of the Amalgamated Society of Engineers bringing to a friendly and satisfactory termination the most serious and far-reaching labour dispute this country has ever seen.

For some time it was fairly open to belief that the odds were in favour of a satisfactory solution to every one of the questions involved, but for motives which can only be attributed to the labour leaders the fight still goes on.

But now that the employers are federated in their hundreds, and are gradually filling their shops with men who are turning out better work and in larger quantities than their unionist predecessors, why should there not be formed amongst these fresh hands a new trades union, with rules and regulations which should not subject them body and soul to the tyranny of self-appointed task-masters, and which should be managed by a controlling body composed of equal numbers of masters and delegates of the men?

Such a combination of management would, in effect, be no more nor less than analagous to the assemblage which foregathered in the Westminster Palace Hotel; but instead of being called together at a given moment for a specific object, the representatives of conflicting interests would be always on hand to adjust disputes which might arise in their own union, or if mutual agreement should at any time be rendered difficult, the services of a well-known public man as arbitrator could be requisitioned whose award would be unhesitatingly and willingly accepted by both parties. As matters now stand, employers indignantly reject the notion that any outside interference is called for to suggest terms of settlement, and unionists are too prone, after having once accepted an arbitrator's award, to repudiate their share of the transaction when it suits them so to do.

The secretary—for in this functionary of trades unionism seems to be vested the sole power of influencing his lamb-like followers for good or evil—should be neither selected from the ranks of labour, nor an employer, but an impartial, unbiassed, and highly educated man, who would devote his time to the true interests of his Association, and not take advantage of his position to further his own insatiable desires for notoriety.

Through the intermediary of such an official, representatives of labour might be in closer touch with the employers, and for once in their lives they might perhaps arrive at a reasonable sense of what limitations of capital, hours of labour, and output of machinery are possible, or undesirable. "The men," says the monthly report of the National Boot and Shoe operatives, "have fought nobly, and the result of the ballot shows that they intend, *if unable to get a satisfactory settlement* (the italics are ours), to continue the struggle."

Labour organisations, excepting perhaps a few such as the boiler makers and their able representative, Mr. Knight, seem all alike. They lose sight of the fact that what may be eminently satisfactory to the men, may be quite the opposite to their employers, and so they determine to "fight nobly," instead of trying to secure peace and plenty by giving as well as taking.

Hitherto the attitude of masters and workmen has been one of armed neutrality, each looking after their individual interests; the combined interests of both might be served to real advantage by combining harmoniously together to do the best for one another, and the rules and regulations of such a society as we suggest could be culled from the most salient points of the proposals of the employers, and the counter-propositions of the unionists, as put forward at the late Conference. Only really qualified men should be admitted to membership, and instead of levelling down, as has been the policy of the A.S.E. for so long, one object of the new union should be levelling up.

We have purposely refrained from asking the opinions of either employers or men as to the feasibility of such a scheme as we put forward, and we present the idea for what it is worth; but if it could be started on a fairly sound and practicable basis, details of working arrangements would readily present themselves, and it is not difficult to conceive of the really able and intelligent members of the union over which Mr. Barnes so autocratically presides seceding from his tyrannical control and joining a body in which all questions of capital and labour might be harmoniously arranged, without recourse to an apparently indefinite strike with all its attendant evil consequences to those out of employ and to the poor families dependent upon these brave sons of toil.

Naturally we would prefer to see every man free to sell his individual labour to the best advantage to himself, but if trades unions must exist for the protection of the interests of the workers, then surely anything would be better than the society controlled by Mr. Barnes, and the fanatical crusade which he for so many months has been, and is still, preaching to his misguided followers.

In this hour of chastened discretion there is yet time for the members of the Amalgamated Society of Engineers to turn from the error of their ways; if they let the golden opportunity now go by another three months will see their occupation gone.

To say that such an idea as is here propounded is impracticable, unworkable, and impossible to carry into effect because such a combination has never before been brought about in trades unionism, is not quite convincing; but, whether it is or is not a feasible one, our suggestion may instigate others to attempt to find a way of mitigating if not wholly eliminating the disastrous effects of the too oft-recurring strikes in our industrial world.

LOCALISATION OF BREAKS AND PARTIAL EARTH FAULTS IN SUBMARINE CABLES.

In the *Electrician* of October 15th, 1897, an article appeared by Mr. Schaefer, entitled "A New Method of Localising Total Breaks in Submarine Cables," in which the author advances certain so-called *laws* dealing with the resistance of faults under varying current strengths entirely at variance with Kennelly's laws, which have been hitherto accepted as being correct.

Before entering into the relative merits of the two tests—Kennelly's *v.* Schaefer's, it would be as well to place before our readers, as concisely as possible, a short description of Kennelly's alternative methods, the laws governing the same, and also the modified *laws* advanced by Mr. Schaefer.

On March 24th, 1887, a paper by Mr. A. E. Kennelly on "The Resistance of Faults in Submarine Cables," was read before the Society of Telegraph Engineers and Electricians, in which the following laws are given as the basis of a test for localising a break:—

1. The resistance to a constant current varies inversely as the square root of the exposed area.

2. The resistance of a constant area varies inversely as the square root of the current strength—or in other words—the resistance of the break is halved when the current is increased to four times the strength.

The method of taking this test is fully described in Kempe's "Handbook of Electrical Testing," so that the following particulars will suffice for our present purpose. In Kennelly's test, two bridge measurements are taken to *false zero*—or by reproduced deflections—with varying strengths of current, which, to conform to the law, must not exceed a maximum of 25 milliamperes.

If R_1 be the resistance obtained with a current to line of C_1 ma.

If R_2 be the resistance obtained with a current to line of C_2 ma.,

then by Kennelly's law these resistances are inversely proportional to the square roots of the testing currents employed, *i.e.*,

$$x = \frac{R_1 \sqrt{C_1} - R_2 \sqrt{C_2}}{\sqrt{C_1} - \sqrt{C_2}} \text{ ohms.} \qquad (A)$$

For greater convenience, and for facilitating calculation, it is advisable to use currents in the proportion of 4 to 1, so that the distance to the break by the simplified formula becomes

$$x = R_1 (R_2 - R_1) \text{ ohms,} \qquad (B)$$

where R_1 = resistance measured with the higher battery power C_1,

„ R_2 = resistance measured with the lower battery power C_2.

Kennelly's Second Method.—In an article "On the Localisation of a Complete Fracture in a Submarine Cable by Bridge Measurement to *Instrument Zero*," which appeared in the *Electrician* of October 14th and 21st, 1887, Mr. Kennelly describes another method whereby the resistance of the break is eliminated by taking three bridge balances to *instrument zero*, with different current strengths to line. The following ratios for the three current strengths he found to give satisfactory results, viz., 1—4—9, or 1—2·25—16, or 1—4—16.

The following formulæ are given for determining the resistance x up to the fault

$$x = \frac{A + C}{2} - 4 (B - C) \text{ with battery ratios 1—4—9,}$$

and

$$x = \frac{A + 2C}{3} - 2 (B - C) \text{ with battery ratios 1—4—16.}$$

Where C = balance with the highest current and A with the lowest.

The current strength in this test is *not* limited to 25 ma.

Having referred thus briefly to Kennelly's two methods of localising faults in submarine cables, the one to *false*, the other to *instrument* or *scale* zero, we will now deal with Mr. Schaefer's substituted laws.

"The results of my observations will be found in the following connected laws (Laws I. to IV.) [see *Electrician*, p. 812] which hold good for breaks of copper in sea-water, and for tests taken with zinc to line, even when the current attains so high a figure as 50 milliamperes per square centimetre exposed." Two of these laws more immediately referring to localisation tests he enunciates as follows:

Law I.—"When the exposed area is constant its resistance varies inversely as the 1·3 root of the current strength."

Law IV.—"The resistance to a constant current varies inversely as the 4·3 root of the area exposed."

Mr. Schaefer then continues, "Having established the truth of these laws, we infer that the resistance of an exposure is halved when the current is increased to 2·46 times its first value."

After disposing of Mr. Kennelly's law, rather summarily we think, though evidently to his own satisfaction, Mr. Schaefer asks us to accept, without proof, his substituted laws. When, however, we come to apply his formula, it does not appear that Mr. Schaefer's results are more exact than those obtained by Mr. Kennelly—indeed, the reverse would appear to be the case.

Several tests with two-current strengths in the ratio of 2·46 to 1, as given by Mr. Schaefer and balancing to *scale zero*, were within 1 to 2 units of the actual distance to the fault *without applying any correction* for the cable current, but when the area of exposure was increased—by employing a core with a heavier conductor—the results were uniformly between 6 and 8 units too high for the same exposure. The "earth current" measured before each test gave a correction varying between 5 and 10$^{\omega}$, but the results proved to be more accurate *without applying any correction* in the manner explained by Mr. Schaefer in his formula. Using Mr. Schaefer's ratio, 2·46 to 1, and balancing to immediate *false zero*, the results were about 8$^{\omega}$ too high.

A comparison of the two tests taken under the conditions stipulated for by the authors, as regards the current strengths, gave, when balancing to *false* zero, the following results for cores:—

$\frac{107}{140}$ $\frac{130}{130}$ $\frac{160}{130}$ $\frac{225}{225}$ $\frac{250}{230}$ $\frac{340}{340}$ $\frac{550}{550}$ Cu G.P. } lbs. per N.M.

2.—Bridge Balances.

Kennelly's, with a battery ratio of 4 to 1, viz, 20·6 and 5·15 ma.

Schaefer's with a battery ratio of 2·46 to 1, viz., 20·6 and 8·37 ma.

Calculated Distance x to Fault.

By Kennelly.—Results were within 2$^{\omega}$ of the correct distance with cores 107 to 160 lbs. copper, and those of cores 225 to 550 lbs. copper were *absolutely correct.*

By Schaefer.—Results uniformly about 8$^{\omega}$ too high.

Note.—Resistance of faults small, there being half an inch of conductor exposed.

"Clean Cut" in Same Cores. L = 2,444$^{\omega}$.

Kennelly's method. Ratio 4 to 1. — Calculated results.—In core 107/140 = 10$^{\omega}$ out; core 160/130 = 3$^{\omega}$ out; and core 225/225 = 2$^{\omega}$ out (placing fault too far away); cores 260, 380, 400, and 550 lbs. Cu per N.M., all correct at 2,444$^{\omega}$.

Schaefer's method. Ratio 2·46 to 1. — Calculated results.—About 36$^{\omega}$ too much with core 107/140; 23$^{\omega}$ too much with core 225/225; and 12$^{\omega}$ too much with core 550/550.

It will be seen from the above results obtained from the application of Kennelly's law and formula, that except in one or two isolated cases, the resistance of the fault was halved when the battery current was quadrupled, and that the values from Mr. Schaefer's formula were not so satisfactory, the error being much greater for the smaller exposure.

Again substituting Mr. Schaefer's law for the law given by Mr. Kennelly, the latter's formula, A, becomes:—

$$x = \frac{R_1 \sqrt[1\cdot3]{C_1} - R_2 \sqrt[1\cdot3]{C_2}}{\sqrt[1\cdot3]{C_1} - \sqrt[1\cdot3]{C_2}}$$

The following results of tests exemplify the respective values of the two formulæ.

Test No. 1.

Measured resistance to fault = 2,444$^{\omega}$.

$R_1 = 2{,}465^{\omega}$ $C_1 = 17$ ma.
$R_2 = 2{,}478^{\omega}$ $C_2 = 6{\cdot}5$ „ } Ratio 2·6 to 1.

Calculated resistance to fault
by Schaefer = 2,453$^{\omega}$ = 9$^{\omega}$ too far.
Calculated resistance to fault
by Kennelly = 2,444$^{\omega}$, correct.

Test No. 2.

$R_1 = 2{,}498^{\omega}$ $C_1 = 17$ ma.
$R_2 = 2{,}552^{\omega}$ $C_2 = 4{\cdot}25$ „ } Ratio = 4 to 1.

Calculated resistance to fault
by Schaefer = 2,470$^{\omega}$ = 26$^{\omega}$ too far.
Calculated resistance to fault
by Kennelly = 2,444$^{\omega}$, correct.

Test No. 3.

$R_1 = 2{,}504$ $C_1 = 17$ ma.
$R_2 = 2{,}538$ $C_2 = 6{\cdot}5$ „ } Ratio 2·6 to 1.

Calculated resistance to fault
by Schaefer = 2,473$^{\omega}$ = 29$^{\omega}$ too far.
Calculated resistance to fault
by Kennelly = 2,448$^{\omega}$ = 4$^{\omega}$ too far.

Note.—A great number of similar tests were taken and gave the same comparative results, all being in favour of Kennelly's test.

Balancing to Scale Zero.

Length of exposure about ½ inch.

Kennelly's (modified) Test.—*Three* readings to scale zero, ratios 4—2—1.

Schaefer's Test.—*Two* readings to scale zero, ratios 2·46 to 1, with E.C. correction.

Kennelly's Test.—Mean results gave correct resistance to fault = 2,444$^{\omega}$.

Schaefer's Test.—Within 1 to 2$^{\omega}$, with cores 107 to 160 lbs. Cu, but with cores varying from 225 to 550 lbs., results were 6$^{\omega}$ to 7$^{\omega}$ too high.

Clean Cut.

Kennelly's Test.—Mean 6$^{\omega}$ too high (placing fault too far away).

Schaefer's Test.—Mean 19$^{\omega}$ too high (placing fault too far away).

Mr. Schaefer's experiments no doubt show that his formula gives a very approximate result when balancing to scale zero, and provided that there is a *tolerably large surface of conductor exposed*, but practical results are the best criterion, and according to that standard we are unable to see, and it will require greater proof than what we can gather, that he has proved the inaccuracy of Kennelly's law. On the contrary, the tests given point to the opposite conclusion.

Further tests taken on different sized conductors having about ⅛th inch exposure, with two balances to *scale zero*, and with a battery ratio of 2·7 to 1, viz., respectively 20·7 and 7·59 ma., showed the calculated resistance to the breaks to be very exact, using Kennelly's modified formula, B, when balancing to *false zero*.

Fault Exposure of ⅛th Inch in Various Cores, Having Conductors of 107 to 550 lbs. per N.M.

Resistance of an Artificial Line in Circuit with the exposed end of Core = 2,444$^{\omega}$.

Ratio of Currents 20·7 : 7·59 *ma., i.e., 2·7 to* 1.

Weight of core conductor in lbs. per N.M.	107	130	160	225	300	340	550	400
R_1	2,493	2,488	2,490	2,489	2,480	2,482	2,479	2,484
R_2	2,542	2,532	2,535	2,533	2,516	2,519	2,513	2,525
Then by formula (B), $x = R_1 - (R_2 - R_1)$								
x =	2,444	2,444	2,445	2,445	2,444	2,445	2,445	2,443

It will be seen that the apparent resistance of the fault was halved when the battery was increased 2·7 times its first value; thus with conductor 107 lbs., the

Fault resistance with 7·59 ma. = 2,542 − 2,444 = 98$^{\omega}$
„ „ „ 20·7 ma. = 2,493 − 2,444 = 49
Difference = 49

No correction was made for the cable current which, being measured before applying the battery in each test gave from 0·25 to 0·31 volts. This, according to Mr. Schaefer's formula would mean a correction of 3 to 4 units to be subtracted from the results—the cable current being in the same direction as the testing current. In the majority of cases the results calculated by the above formula were nearer the correct resistance than those obtained with Mr. Schaefer's formula and "*earth correction.*"

We now turn to Mr. Schaefer's correction for the cable current. Under the designation of cable current is included the earth current proper, the electrolytical current from the break, and the polarisation current. This is effected in Kennelly's first test by taking *two* readings or balances to *false zero*, and in his second test by taking *three* balances to *scale* zero. Mr. Schaefer's method of procedure differs in several important particulars. For instance, before applying the testing battery, he takes the constant of a standard cell—having a known E.M.F.—by passing the current from same through a high resistance and noting the deflection obtained. Secondly, he measures the current from cable under the same conditions, and from these two readings calculates the E.M.F. of the cable current, and also the resistance effect which this current offers to the testing battery. How this resistance effect—whether additive or subtractive—is calculated, is explained in the description of his test. See *Electrician*, p. 815, October 15th, 1897.

Mr. Schaefer evidently assumes that the "resistance" set up by the cable current remains constant, for this resistance effect is calculated from a value obtained by measuring the cable current before applying the testing current, and is, therefore, independent of any polarisation resulting from the testing battery. This correction is unsound in principle, since the polarisation component of the cable current will vary greatly under the two testing currents. For example, the *E.C.* measured *before* applying the testing battery may be equal to, say, 0·5 volt, necessitating, perhaps, a correction of 16 ohms, according to Mr. Schaefer's formula, and yet if the *E.C.* is measured immediately *after* the two balances are taken, the E.M.F. of the same may have fallen considerably, or even assumed an opposite polarity due to the effect of the testing current.

That Mr. Schaefer's *E.C. correction* is not reliable is shown by tests given below, and it is a singular fact that in these tests the results obtained with the two readings to *scale* zero and without the E.C. correction, are nearer the actual position of the break than when this correction is applied, whether it be negative or positive.

Examples of Tests, Applying E.C. Correction and Balancing to *Scale* Zero. Calculated by Mr. Schaefer's Formula.

¼-*inch Exposure of Conductor in Core* $^{107}/_{140}$.

Deflection standard cell (1 volt) through 3,000$^{\omega}$ = 156 divisions. E.C. measured through same resistance—see below.

	M.A. through break.	Ratio of currents.	K 1.		
No. 1.	20·2 / 8·27	2·442	2·014	$A_1 = 2{,}492^{\omega}$	E.C. measured *before* test = 60 +. Same direction as testing current.
				$B_1 = 2{,}539$	E.C. measured *after* test = 17 +. Immediate.
No. 2	37·3 / 19·96	1·870	2·62	$A_1 = 2{,}476^{\omega}$	E.C. measured *before* test = 10 +.
				$B_1 = 2{,}492^{\omega}$	E.C. measured after test not taken.
No. 3.	20·0 / 10·4	1·923	2·56	$A_1 = 2{,}490^{\omega}$	E.C. measured *before* test = 10 +.
				$B_1 = 2{,}520$	E.C. measured immediately after test = 18 −.

Calculated Results.

x without applying E.C. correction.	E.C. correction from current measured *before* test subtractive.	*x* corrected for E.C.	Value of E.C. from current measured *after* t st immediate.	*x* corrected for this second value.
1 = 2,441·34$^{\omega}$	8·78$^{\omega}$	2,435·56	2·53$^{\omega}$ subt.	2,441·81
2 = 2,449·92	0·70	2,449·22	...	...
3 = 2,443·26	1·40	2,441·86	2·52 add.	2,445·78

Measured resistance to fault = 2,444$^{\omega}$.

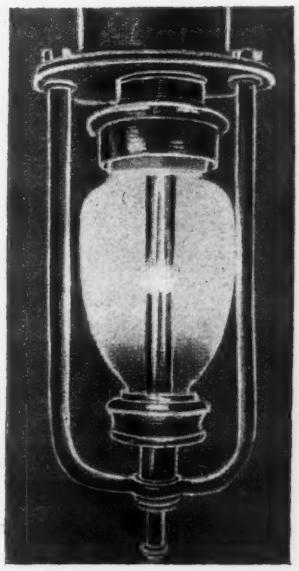
With regard to Mr. Schaefer's formula holding good for currents of 50 ma. per square centimetre exposed, we may say that we do not recommend as a minimum testing current less than 4 to 5 milliamperes through the break, irrespective of surface exposure, while, on the other hand, if the exposure be small, the best results will be obtained if the current does not exceed 20 or 25 ma., because the application of a heavy current to a small exposure will develop gas at the fault and render balancing a matter of difficulty owing to sudden changes.

The statement that localisation of faults can be effected by means of Mr. Schaefer's test "with a rapidity hitherto unapproached," is incorrect, and the author has evidently not seen two very simple tests to *scale* zero, the one by Mr. Herbert E. Cann, fully described in the Electrical Review, of December 18th, 1896, which requires no stronger currents than those employed by Mr. Schaefer, and certainly compares favourably in point of simplicity, while the second, by Mr. J. Rymer-Jones—a modification of Mr. Cann's formula—was published in these columns, January 1st, 1897, requires only half the battery power, and is therefore applicable to much longer cables, and requires only two measurements of the conductor resistance.

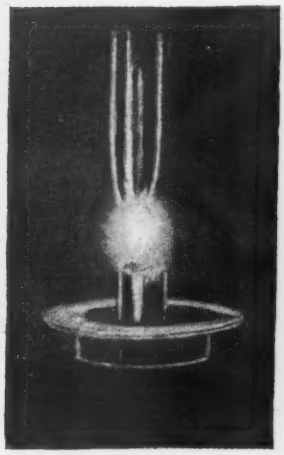
TESTS OF AN ALTERNATING CURRENT ENCLOSED ARC LAMP.*

Some interesting and instructive tests have recently been made on an alternating current enclosed arc lamp, and photographically recorded by the light of the arc itself, disclosing some peculiar features of this particular type of arc. The tests were conducted by Mr. M. H. Baker on the Puritan enclosed arc lamp, with the idea of showing to lamp users and central station men the appearance of the normal arc and the symptoms of the various troubles that may occur.

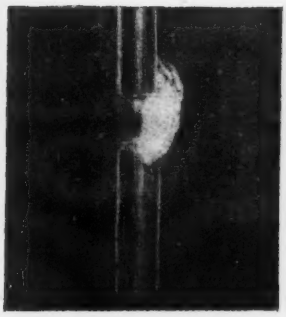
The Puritan arc lamp, when working under normal conditions, is supplied by alternating current at 100 volts pressure, the voltage being reduced to 65 volts across the arc by an inductive resistance, the pressure around which is also about 65 volts. When the normal current of 6 amperes is furnished, the apparent power consumption is obviously 600 watts. The real power consumption, however, owing to the lag due to the inductive resistance, is only about 400 watts. The actual loss of power in the inductive resistance, including both iron and copper losses, is from 25 to 35 watts, giving an efficiency, or ratio of watts consumed in arc to watts taken from the mains, of about 94 per cent. Careful experiments show that the resistance of the arc itself is non-inductive, the current through the arc being exactly—so far as can be determined—in phase with the E.M.F. applied to the carbons. The arc is enclosed in an inner globe normally of opalescent glass, but for the purpose of these experiments of clear glass, clamped to the lower carbon with a packing of asbestos and covered with a heavy copper bottle cap, in which the upper carbon fits as closely as the requirements of free movement will allow. The length of the arc is controlled by a clockwork feeding mechanism and a series solenoid, the plunger of which is so arranged that as the current weakens the upper carbon is lowered, until the minimum allowable length of arc is reached, when the clockwork detent is released, the upper carbon falls and the increased current causes the solenoid to again pick up the carbon. One-half inch "Electra" cored carbons are used, the cored carbons being found much better for alternating enclosed arcs than solid carbons, in that the arc does not with the cored carbons tend to "climb" up the side of the carbon, as frequently occurs with solid carbons. The cored centres burn away, leaving central holes which seem to hold the arc in its travels close to the centre, preventing its running out to and around the edge of the carbons. The travelling and climbing tendency of the alternating arc appears to be greater than that of the direct current arc, owing probably to its frequent partial extinguishment. The alternating enclosed arc is sometimes made with one solid and one cored carbon, by which the voltage may be raised somewhat, but the use of two solid carbons is practically impossible on account of the tendency to extinguishment.



Arc showing Globe, Clamp, and Bottle Cap.



Arc with Broken Globe.



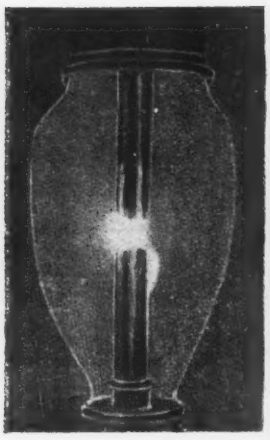
Lamp Designed for 16,000 Alternations on 7,200 Circuit.

The appearance of the arc when under normal conditions may be seen in one of the accompanying illustrations. The length can easily be determined by remembering that the carbons are $\frac{1}{2}$ inch in diameter. The normal length is about $\frac{3}{8}$ inch; the carbons' ends are flat, with fairly sharp edges, as may be seen. The effect of a broken enclosing

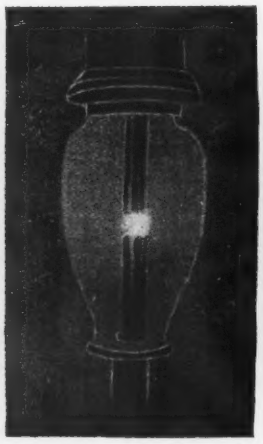
* *Electrical World.*

globe or loose clamping about the lower carbons may be seen in the ragged or rounded appearance of the normally flat ends of the carbons. The greater the admission of air, and consequently the draught passing the carbons, the more will the ends be rounded until the condition of the open arc are reached, when the end of the upper carbon is shaped practically like that of a sharpened pencil. This is obviously due to the draught of air passing vertically by the arc and burning off the exposed surface of the carbons.

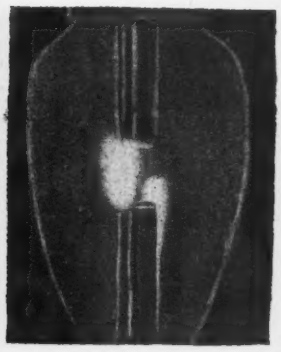
Another illustration shows the effect of abnormally high voltage on the arc. This was obtained by supplying a lamp built for 100 volts with current at 115 volts, the voltage across the arc rising to some 80 or 85 volts, owing to the increased length necessary to hold back the current. The flaming effect can be readily seen and its appearance should be noted, as it is invariably the sign of too great a current consumption for the size of the carbon. Such an abnormally large current consumption may be due to several causes, of which the following may be mentioned:—Extra high voltage on the supply lines; poor adjustment of the regulating mechanism, or a lower frequency than that for which the lamp was designed, the last reducing the choking effect of the inductive resistance, thereby allowing more current to pass. An extreme case of the last cause is exhibited in the lamp built for 16,000 alternations and working on a circuit of 7,200 alternations. In the reverse case of a lamp built for 7,200 alternations and supplied with current at a frequency of 16,000 alternations, the arc, as a rule, will not burn at all, owing to the extreme choking effect of the inductive resistance.



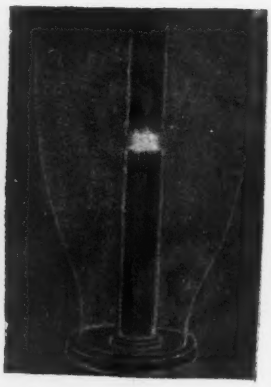
Normal Arc showing Eccentricity.



Normal Arc, 6-Amp. at 65 Volts.



Voltage too High.



Voltage too Low.

In the case of low voltage, shown in the illustration, a lamp built for 100 volts is supplied from a circuit at 90 volts pressure, the arc being shorter and weaker, owing to the reduced current. The minimum commercial current strength which can be depended upon for alternating enclosed arcs appears to be about 5½ amperes, smaller currents causing a rapid falling off of the illuminating effect and lighting efficiency.

The whole series of photographs exhibits, if the camera can be trusted, a highly interesting observation on the source of luminosity. In some of the photographs the centre of the arc appears to be a dark vertical stream from carbon to carbon, resembling the central dark stream of a Bunsen gas burner. This stream seems to be surrounded by an envelope of highly luminous vapour, which shares with the carbon tips the generation of the light. At either end of the dark central stream in some of the photographs appears a spot still darker by comparison, close to the carbon tips, and practically in a position where the appearance of a crater would be expected. The effect of the arc on the gases in the enclosing chamber is to form carbon monoxide, which is readily proven by the appearance of the blue flame at the top of the chamber when the bottle cap is removed.

THE MECHANICVILLE-SCHENECTADY POWER TRANSMISSION.

The *Electrical World* for November 13th, 1897, contains an account by Mr. C. P. Steinmetz of the power station at Mechanicville and the transmission to the General Electric Works at Schenectady, which we here transcribe in part. The whole installation has been carefully planned by engineers who are thoroughly acquainted with the latest developments and improvements in transmission of power by alternating currents, and consequently is of great interest.

After much consideration the frequency selected was 40 complete cycles per second. Whereas a moderately high frequency is best for lighting, and a corresponding low frequency for rotary converters and induction motor work, a happy mean has to be struck in order to suit all purposes to the best advantage.

The generators to be installed at Mechanicville are 40 cycles untooth three-phase revolving field type, of 40 poles, and 750 kilowatts output, and wound to generate directly 12,000 volts, so as to avoid the necessity of step-up transformers. The revolving field type was adopted in preference to the revolving armature type, since the stationary armature winding of the former allows the construction of a generator to produce directly the transmission voltage, and in preference to the inductor type, since the latter requires very high density in the magnetic structure, and thus gives a lesser margin in voltage and in speed than the revolving field type, which latter allows the use of fairly low saturation of the magnetic circuit, thus giving a nearly straight saturation curve. Such a saturation curve, while making the machine slightly inferior in regulation to the same machine with an over-saturated magnetic circuit, is preferable in power transmission. It allows a considerable increase of voltage when needed, for instance, to cover excessive drop in voltage in lines due to heavy loads, &c., and permits the voltage to be maintained, even if the speed is low.

The generators are arranged to be operated in parallel at constant voltage in the generating station.

At first 2,000 horse-power will be transmitted to the General Electric Company's factories at Schenectady over a line of about 18 miles length, consisting of three wires of No. 000 B. & S. This large size of wire has been chosen in preference to the use of several small wires in parallel in order to give the line as high a self-induction as possible, such being considered desirable when rotary converters and synchronous motors are used.

The receiving apparatus in Schenectady consists of two synchronous motors of 500 and 100 kilowatts respectively for the testing department, and three rotary converters of 400 kilowatts for the operation of the factories.

The testing department is being driven by a synchronous motor, in preference to an induction motor, on account o.

the higher efficiency, the greater constancy of speed and the control which a large synchronous motor gives over the power factor of the entire plant.

The three rotaries in the power house will be of the double commutator type, each containing two commutators and two sets of collecting rings, fed from independent secondary coils of the same set of air-blast transformers. These two commutators connected in parallel give 250 volts for the operation of the factories, while, when connected in series, they give 500 volts for testing. The reason of this is, that the factories are at present operated by 250-volt motors, and it is considered undesirable to change them since the present steam plant will be retained as reserve, in case of a failure of the power from Mechanicville. For the operation of the factories the 250-volt circuit is very convenient, since it allows the operation of the lights from the same circuit by an Edison three-wire system.

The testing department, however, is operated by a 500-volt circuit, since this voltage is preferable in testing direct current machines.

While usually the testing department takes its power from a railway generator driven by the 500-kilowatt synchronous motor, it is occasionally desirable and necessary to have a larger power available, as for testing large generators, or heavy railway apparatus. Therefore, when a larger amount of power is required for testing than can be given by the synchronous motor, it will be supplemented by the rotary converters. With their commutators connected in series for 500 volts, they can be operated in parallel with the railway generator driven by the synchronous motor in the testing department.

All the rotaries will be operated in parallel, and all motors in the factories, the factory railway, the lights in the factory and office building will be operated from the same direct current circuit; also the lights on the Edison three-wire system.

In this transmission plant the whole system is self-regulating for constant voltage in the direct current system. For this purpose all the rotaries are supplied with shunt fields and with very powerful series fields, which are all joined together so that the rotaries in operation form one unit. The rheostats in the shunt and series fields will be set so that with constant voltage in the generating station at no load, the counter E.M.F. of the rotaries as given by their shunt fields is below the impressed E.M.F. and a lagging current thereby produced. With such a lagging current the self-induction of the lines is in opposition to the voltage, and reduces the latter so as to give the desired voltage of 250 at the commutator brushes of the rotaries.

With increasing load the counter E.M.F. of the rotaries rises rapidly, due to the series field, till at full load and overload it exceeds the impressed E.M.F., and a leading current ensues. With a leading current, however, the E.M.F. of self-induction of the lines is brought partly in phase with their voltage, and thus increases it, so that in spite of the increased line current, and thus increased energy loss in the line, with constant generator voltage the same voltage is produced at the commutator brushes of the rotaries at full load and overload as at no load.

This control is perfectly automatic, and would be sufficient if the synchronous motors did not take power also over the same line in amounts varying independently of the load on the rotaries. To take care of this small series transformers will be inserted in the lines leading to the synchronous motors and feed a small synchronous motor generator, which controls the shunt fields of the rotaries, so that, independent of the load on the lines, and the distribution of the load between the synchronous motors and the rotary converters, the voltage will automatically be maintained constant at the commutator brushes of the rotaries by the combined action of their shunt and series fields, leaving nothing for hand regulation except the re-adjusting of the rheostats in case of a change of the number of rotaries in operation.

Wireless Telegraphy in France.—A few days ago M. Ducretet made some very successful experiments of wireless telegraphy, in presence of the President of the French Republic and of his military household. He is constructing some very powerful apparatus, which will allow him to signal at considerable distance.

LEADING-IN WIRE FOR ELECTRIC INCANDESCENT LAMPS.

By SHERARD COWPER-COLES, Assoc.M.Inst.C.E, M.I.E.E.

Platinum wire at the present time is used exclusively to convey the current of electricity through the glass bulb to the filament. Platinum is employed because it has a coefficient of expansion nearly the same as that of glass, as shown by the following table:—

Coefficients of Expansion at Ordinary Temperatures.—(Solids).

Material.	Coefficient of expansion.	
	°F.	°C.
Aluminium	·0000114	·0000206
Brass	·0000104	·0000187
Bronze	·0000100	·0000180
Copper	·00000961	·0000173
Glass ... ... from	·00000399	·00000719
„ ... ... to	·00000521	·00000938
Gold	·00000841	·0000151
Iron, cast	·00000587	·0000106
„ wrought	·00000677	·0000122
Lead	·0000158	·0000284
Platinum	·00000494	·00000890
Steel, untempered	·00000611	·0000110
„ tempered	·00000689	·0000124
Tin	·0000116	·0000209
Zinc	·0000163	·0000293

Platinum can be fused to crystal or lead glass with great facility, as the platinum will stand heating in the blow-pipe flame without melting or oxidising during the process of sealing-in. The fusing is supposed to give rise to a chemical combination, in which both the silica and the lead of the glass seem to enter. The platinum fused to the glass becomes brittle, and melts at a lower temperature; this phenomena is attributed to the chemical properties of platinum. Various means have been tried to obviate the use of platinum on account of the expense. The value of the platinum in each lamp varies from ½d. to 1d.; the present price of platinum wire suitable for incandescent lamps is 58s. 6d. per oz. The price offered by dealers in old lamps for Ediswan is 8s. 6d. per 100, other makers about 5s. 6d. Seven lamps of different make were taken and the platinum wire carefully removed and weighed, when the average weight of platinum per lamp was found to be ·05589 of a gramme. The number of lamps in use at the present time is computed by Mr. Swan in various parts of the world, expressed in 8 C.P. equivalent, to be not less than 50 millions, and the value of the platinum may be roughly estimated at £261,797.

Several experimenters have endeavoured to produce alloys having the same coefficient of expansion as glass, but different batches of the alloy have been found to vary considerably.

To economise the amount of platinum, many lamps have short pieces of platinum wire fused into the glass, to which are attached pieces of copper wire; the ends of the copper wire are held in a small pointed blow-pipe flame, the copper quickly melts, and a small bead is formed; while this bead is liquid, the hot end of the platinum wire is stuck into it, and both are removed from the flame, when it is found they are firmly united. In the Robertson lamp the platinum wire is cut to lengths by machinery, a small tube formed in one end of each wire, to which the filament is slipped and retained by a slight pressure from a pair of pliers. William Crookes, in 1881, took out a patent for improvements in the construction and manufacture of electric lamps, in which he describes the use of a combined wire, having a core of copper, silver, or gold, and a surface of platinum. This wire was put to practical use, but tight joints could not be maintained. In 1890 a patent was secured for producing leading-in wires, by drawing a platinum tube over an iron core, which had previously been prepared by coating it with tin or gold. Wires thus manufactured were found to be unreliable, and the cost of manufacture very considerable. Rudolf Langhans, in 1891, took out a patent, in which he describes the use of iron or nickel, or alloys of iron or nickel, or of both, or of either of them with anti-

mony, these baser metals being covered with platinum, iron, having a coefficient of expansion ·00001182, antimony ·0000183, and nickel ·00001286. Antimony cannot be used alone on account of its low melting point and tendency to break. Owing, however, to the fact that the coefficient of expansion of an alloy is the mean of the coefficient of expansion of its components, antimony can be used to lower the coefficient of expansion of the iron and nickel. In such alloys the iron or nickel must be in considerable excess to give the necessary strength; 1 to 5 per cent. of antimony is suitable. The wire made from such an alloy is covered with platinum by placing it in a platinum tube, and then drawing it down in the usual way. In 1893 Mr. Proctor suggested making leading-in wires of iron, enamelling them, and then embodying them in glass, approaching the enamel in composition.

An alloy has also been tried composed of 95 per cent. tin and 5 parts copper.

ELECTRICITY AND DERMATOLOGY.

By W. S. HEDLEY, M.D.

The action of electricity on the skin and its appendages is no new study. John Wesley mentions the one form of electricity known in his day, as "curing baldness"; and every medical man who is accustomed to use the Wimshurst, the Holtz, or Töpler machine for purposes of treatment must be aware that there is to be found in the static breeze a far more effective "application for the hair" than any of the numerous "restoratives" of the tribe of Macassar.

In 1892 Gautier and Larat successfully used the alternating current of the street mains in the treatment of chronic eczema. In 1895 Bordier carried out experiments showing that the action on the skin of the "souffle" from the negative terminal of the static machine is more powerful both in point of vasomotor and sensory effect than is that proceeding from the positive pole, and therefore it is that the negative discharge is more effective than the positive in the treatment of eczema and varicose ulcer. In 1896 Dr. Coignet, of Lyons, demonstrated the rapid cure of certain forms of specific ulceration by subjecting them on one or two occasions for two or three minutes to the discharge of a high frequency apparatus, by the unipolar method. Such mild achievements seem about to be eclipsed by a coming event which already sends its shadow across the waters—of course, the waters of the Atlantic. It is proposed by means of a powerful static charge to rid the surface of the body of micro-organisms, and other conditions upon which cutaneous disease may depend. The interviewer has once more penetrated into the laboratory of Mr. Tesla, and apparently taken a peep into his thoughts.

Commencing with two elementary electrical facts, viz. (1) that two bodies charged with the same kind of electricity repel each other, and (2) that if a body be charged with electricity from a static machine the electricity accumulates on the surface; it is explained that any minute light bodies that may be on the charged surface will become similarly charged, and that, therefore, under the law of repulsion, such light bodies will be thrown off. The greater the electrical pressure the greater the force of repulsion, this action being further increased by the fact that such minute bodies are practically points, and it is on points that electricity preferably accumulates. In illustration, the case of a brass ball covered with bronze paint is instanced. If such a ball be charged to a high pressure the bronze will be forced from the brass surface and scattered. Applying this to the human body, it is conceivable that under the influence of a high charge the skin might be made to throw off extraneous particles, such as constitute certain pathogenic micro-organisms. It is stated that by means of apparatus "the exact description of which must be kept secret for a time yet," the person operated upon has appeared to be "clouded in a haze of luminous mist." M. Tesla is reported to have suggested the possibility of thus "completely enveloping the human body in an actual sheet of flame without injury to the skin or nerves"—and why not?

HOW SHOULD BATTERY CELLS BE TESTED?

Experimental Tests of Storage Batteries.

By RANKIN KENNEDY.

(*Concluded from page* 884.)

The first stages of a new storage battery or plate for a new cell should, from the first, be conducted by careful tests.

It may be supposed that such testing is most expensive; time was when that was so, before the introduction of cell testers of considerable accuracy at a low price.

It is folly to make up large batteries with new plates or new solutions before approximately estimating their value by tests on a small scale, quickly made at small expense, on a single cell or couple. I propose to describe a set of apparatus

Table VII.

	1	2	3	4	5
Name of cell... ...	A	Ampere hours.	B	Ampere hours.	Ampere hours.
Weight of positive ...	2 lbs.	A	20 lbs	B	A × 10
„ negative ...	2 lbs.	Battery.	20 lbs.	Battery.	A = $\frac{1}{10}$ B
Discharge amperes ...	...	...	...	...	In weight.
Per pound of positive	0·75	15	0·75	130	150
„ „ negative					
2nd discharge positive	1·0	10	1·0	100	100
„ „ negative					

with which cells of from 2 to 7 amperes discharge rate can be tested within an error of 1 per cent.; it is not advisable to go above 5 amperes for a test in experimenting.

All tests are made to obtain results comparable with some standard results up to date; we cannot accept published results by makers or inventors in every case, but in most cases the ampere-hours or watt-hours at two or three rates of discharge per pound of plates can be obtained without tests of the best cells in the market.

If they cannot be obtained, then there is nothing for us to do but to get a positive and two negatives, of as near the same weight as the new plates, one positive and two negatives.

Whichever plates are selected for a standard, they are to be tested, first, at the rate which the makers give, and then at a rate above and one below that figure.

First, however, we must describe the necessary apparatus:—

One ammeter reading from 0 to 5 amperes ...	£1	10	0
„ voltmeter „ „ 0 to 3 volts ...	1	12	6
Two Silvertown low resistance batteries (10-pint), giving 5 amperes 2 volts each	1	0	0
Hydrometer (flat) by Deans	0	2	6
	£4	4	6

The ammeter referred to is a spring-controlled one, very sensitive, reading equally well in any position; hysteresis error very small, scale fairly long.

The voltmeter is of a well-known make, and as its range of accuracy requires to be between 1·6 and 2·6, only over 1 volt it is easily verified.

For this work the Silvertown battery is very good indeed. We never want more output rate than 10 watts, and unless we are within reach of a municipal supply, no other generator can work continuously with less trouble and at less expense; two cells require about 1½ gallons of negative solution at 1s. 2d. per gallon, and 5 pints of positive solution at 3½d. per gallon, say total cost 1s. 9d. + 6d. = 2s. 3d. a charge; 27d. for, say, 80 ampere-hours = 0·34 pence per ampere-hour. The zinc and mercury costs 7s. for two cells; this lasts for 200 ampere-hours at least, on a 3 to 4-ampere discharge. $\frac{84}{200}$ = 0·42 pence per ampere-hour for zinc; 0·42 + 0·34 pence = 0·76 pence per ampere-hour; per watt-hour it will be about half that, say 0·39 pence.

Thus if a cell under test takes 100 watt-hours, the cost of the test will be about 3s. 4d. for battery materials for one

charge; this looks high, especially as nothing is put down for labour, cleaning and charging battery. On the other hand, if we use an engine, dynamo and attendant, it runs higher.

Again, if we take a public supply, we must pay for 100 or 200 volts, while only using 2·5 volts at most; we have to pay for say, 2·5 × 100 = 250 watts to get the use of 5·25 watts; this raises the cost to 50 times the B.T. unit price, so that it also comes out dearer.

The whole apparatus occupies little space, gives no trouble, no fumes, and works away all right without attention, preparing a charge for a test in the morning.

25 to 30 watt-hours rate of discharge or charge gives a very good size of cell for tests; such tests would cost each about 1s. 8d. for battery, and three tests could be made out of one charge. It is the forming of new plates which eats up our primary battery, for both pasted and Planté plates take a lot of charging before being formed fully.

About 120 hours' incessant charging is required at a rate equal to 0·5 amperes per pound of plates negative, a 25 watt-hour cell will weigh about 2·5 lbs. of negative plate, so that the charge would be 120 hours at 1·25 amperes = a total of 150 ampere-hours, so that we find that at least two charges of the primary battery would be required to form the plates before any tests begin.

After charging up to full forming, only a little more than the discharge is used up at each test in charging.

Now we must get to know what watt-hours is given by the standard storage cell plates at its rated *discharge per pound of plates*. This is absolutely necessary, for we must make the tests on the new plates at exactly the same rates as were used in obtaining the results of the standard plates tests. The plates to be compared must not only be as near as possible same in weight, but must be discharged at same rate per pound.

If a standard set of plates cannot be got of nearly same weight as those to be tested, then a larger set may be taken and cut down to size, then tested, and the results tabulated.

The weight of plates to be taken is to be without connectors or lugs; only the actively immersed plates are to be weighed, therefore the standard plates, after being made to same weight as near as can be estimated, the test plates are, after being tested, deprived of their lugs and connectors and separators, and weighed to get correct weight for comparison.

Another way to compare standard plates with test plates is to take the results of the nearest reliable tests on the standard plates, cut the lugs off and all connectors and separators, and weigh the plates only, then the results can be compared with test by multiplying or dividing by the ratio of weights. Suppose our standard plates weighed 8 lbs. and our test plates 2 lbs., in comparing results of tests at same ampere per pound rate of discharge we would multiply the results of the small test plates by four in comparing them.

Table VII. shows a tabulated form for such tests. Cell A and B are compared. It is supposed that A has a new kind of positive plate, hence the discharge per pound of positive only is taken—equal in both A and B tests as to rates of discharge per pound.

If we were testing a new negative, we would take the tests at equal rates per pound of negatives in the standard plates, if the claim was for a lighter plate at the standard rate of discharge.

If the claim is for an improvement in both plates, we must make two tests; one to get ampere-hours discharge with equal rates per pound of positives, and another with equal rates of negatives in both batteries or cells. This is necessary, for it is hardly possible in two cells to get the rate for the positives equal, and at same time the rate for the negatives also equal.

If the test is for a new solution, we take a pair of well formed plates, and charge them first in the old solution, and get the watt-hours down to a limiting P.D., say, 1·8 volt. We then give the same charge in the new solution, and note the watt-hours given by that test; simple comparison of the two results will at once show if the new solution is better than the old. In testing solutions the hydrometer should be constantly in use, and 15 or 30 minutes' reading of it recorded, and the cell should be in a glass box to watch for any changes visible in the solution.

The tests are not absolutely accurate, but if carefully carried out, will show the experimenter how much or how little progress he has made; they will save him much expense and trouble, and teach him the value of careful observation.

The apparatus can be used for electro-chemical tests, and it is really wonderful what an amount of valuable information and interesting figures can be obtained by this simple apparatus; for these tests, however, five cells are better than two. In a practical electrical engineering school, much could be taught with a few sets of these apparatus, but instead of a primary battery, several experimenters could work from a motor generator transforming from the lighting circuit to 10 volts.

I would have touched on electro-chemical and electro-metallurgical tests, but this article is long enough, and treats only of the storage battery part of the subject.

A motor generator could be used on an electric supply circuit, and then the energy expended would be charged for only; but the first cost of such a generator for 100 volts to 3 would be from £20 to £25, against £2 for battery cells.

ELECTRICITY BY GAS POWER.

THAT gas power will eventually fill a much larger arc in the electrical horizon is very certain. As a growing source of power gas has neither the convenience nor the interest which attach to steam power, save alone in small installations, for which gas, when laid on, is essentially the preferable source of power. But where gas requires to be made of the producer variety gas power can only be approved on the score of utility and economy, and it says much for these qualities that this form of plant is forcing its way into notice. We have before us a report upon the electricity station of the Leyton Urban District Council, by Professor Henry Robinson.

The report is of interest as showing the plant necessary to provide 300-volt continuous current on the three-wire system, at an output which increased from 8,892 units generated in January to 13,464 in March, falling to 8,552 in June, and rising again to 17,893 in October last.

The following is a list of the plant: Three Dowson gas generators, equal to 110 B.H.P. each, but one is lined more thickly to reduce its capacity to 85 B.H.P.; three sets of coolers and scrubbers; one gas-holder, 20 feet diameter by 10 feet high; four gas-engines, each driving a 35-kw. dynamo by belt; two 85-cell Tudor batteries, on the three-wire system, of 880 ampere-hours capacity; three motor transformers to balance the pressure on the two sides of the three-wire system.

The battery is charged off the 300-volt mains, so that the dynamos may be used for direct supply simultaneously with charging as well as to secure the steadying influence of the batteries. Of the 170 cells, 40 are cut out and placed in parallel with either of the two sets of 65 cells remaining which are placed between the outer wires, a cable connection dividing the 130 cells into the two groups of 65, and the cable connection shifts at regular intervals during the charge.

The loss due to the resistance cells placed in series with the 40 group makes the work of charging equal to that of 195 in place of 170 cells, or, say, 12 per cent., the efficiency being thereby reduced from 70 to 63 per cent., a loss which is claimed to be for offset by the advantages.

In addition to the plant enumerated, there is also a steam boiler used to blow the gas producers, and fired from the siftings out of the producer ashes.

The employment of a steam boiler is, we know, very usual with gas producers, but it is very much a question if such an appliance is really necessary.

In the Thwaite plant, for example, the steam boiler is dispensed with, and a fan used to blow the producers. This fan is driven from one of the main engines or from an auxiliary engine, or it can be driven electrically. After being once set to work there is always some gas left in the holder, to allow of the auxiliary gas engine being started and run long enough to set production going at full, and in a storage battery system there is always the means of starting an electrically driven fan. Water for the gas is, of

course, introduced by the steam jet, but where the fan is employed, this is obtained partly by drawing the air over the cooling tanks of the gas engine, and partly from the natural evaporation of the water hearth, which forms at once the most convenient clinkering hearth and seal through which the clinker can be drawn quenched, giving up its heat in doing so to the formation of steam.

In October, 1896, tests were made with the first two engines and producers, the engines running at 160 revolutions and exploding 52 times out of a possible 80. The consumption of anthracite coal and of coke was 1·597 and 0·186 lbs. per unit—a total fuel of 1·783 lbs. per unit, the test lasting 5 hours 35 minutes, 280 units being generated from 500 lbs. of fuel. This is 0·22d. per unit for fuel. In February, 1897, when the sold output was 5,660 units, the fuel per unit sold was 3·92 lbs. At, let us say, 12s. per ton this represents about a farthing per unit, which may be compared with Manchester at 0·11d., Dublin at 1·60d., or Woolwich at 1·75d.

In September of 1887 the fuel per unit sold had fallen to only 3·441 lbs. It appears that from January to October, inclusive of this year, the fuel cost has been ·667 pence per unit sold, the price of the fuel not being given.

There is also still room for improvement, for with increased demand there will be less idle time and the engines will work more closely to their maximum output.

However, the cost per unit generated is perhaps a fairer comparison to make as regards the efficiency of the gas system, for there is a large amount of current not sold and used at the central station itself, as well as the loss on the battery account and distribution.

The lowest weight of fuel per unit generated was 2·35 lbs. in September, the highest being 2·685 in January. These figures are from tests made by Mr. H. C. Bishop, the resident engineer, who made also some tests at full power of two dynamos. The anthracite fuel cost 20s. 6d. per ton at the works, and the run was made under quite normal conditions.

On October 26th the test was with two engines at full load, and on the next day four engines at two-thirds load. They are comparative, therefore, for different loading, especially as they were each of five hours' duration. The following figures, therefore, are useful for this purpose:—Total output in five hours, 319 at full load and 402 at part load. I.H.P. of one engine only 59·5 and 43·5, E.H.P. of one dynamo 43·7 and 29·2.

$$\text{Efficiency} = \frac{\text{E.H.P.}}{\text{I.H.P.}} = 0{\cdot}734 \text{ and } 0{\cdot}670.$$

Total I.H.P. 116·4 and 160·4. Coal per I.H.P. hour, 0·846 and 0·942. Coal per unit generated, 1·543 and 1·88. The calorific capacity of the gas was very even, being 153 and 156, the advantage being on the day of partial load.

To run one engine at full speed requires, on the assumption of a straight line curve, 24·4 lbs. of coal per hour. This represents about half a pound of coal for each full load E.H.P., and each extra E.H.P. beyond no load adds ·57 lb. so that the total consumption at full load is 1·07 lb., these figures showing how important a full load in a gas engine is if economy is to be sought. Of course the light load consumption includes the producer loss as well as the frictional load of unloaded engine and the loss from the producers will be practically the same whether at no load or full load.

As regards other costs of gas power, it appears that the charge for oil, waste and water is only 0·03d. per unit sold, and more than half the production was unsold in every month except September.

The engines are started by a hand pump which forces gas and air into the combustion chamber and there is a winch handle and pinion to turn the crank to the starting position. One man started the four engines in four minutes and ran them up to full speed.

In an electrical station it would be, however, in our opinion better practice to run an electrically-driven shaft under the engines, and turn the engines therefrom by means of a friction bowl pushed up by a hand lever. When thus revolving, each engine would simply draw its gas supply, and should start at once on the gas valve being opened.

On one day only is the gas consumption per I.H.P. given. It was 80 cubic feet per hour at, we presume, 60° F. The gas per electrical horse-power on the same day was nearly 120 feet per hour. As bearing upon the general question of producer gas, these figures may be compared with the published tests made by Mr. W. H. Booth on the Thwaite blast furnace power system. Basing his figures on an assumed production of 200,000 feet of gas per ton of fuel, the consumption of gas per electrical horse-power was found to be 133 feet per hour. The 200,000 cubic feet were obtained from the gas analysis. With slightly different furnace *régimé* and the works' manager's figure of only 180,000 feet per ton, Mr. Booth gives the consumption per E.H.P. as only 105½ cubic feet. These figures entirely neglected the amount of heat that disappeared in the pig bed and in the slag, &c., showing how very efficient as a gas producer the blast furnace proves to be, and indicating not only the high economy to be secured from the method of utilising the waste heat of the blast furnace, but pointing to a time when the manufacture of producer gas will be carried on upon a large scale, the working of producers being best when of large size. Indeed, the blast furnace, though designed to produce pig iron, is an ideal gas producer, and while we envy America her Niagara, we have in England within easy reach of every large town large power producers from which at present very little is being done. Look at the matter from whatever way we will, it appears that gas power in the near future will more and more encroach upon the field hitherto filled by the steam-engine. We do not think that the use of illuminating gas, to give the mixture its courtesy title, will ever prove commercially economical for stations of any serious power. To be a success, gas of the producer type must obviously be employed, and it is most important that the producer plant be constructed in a thoroughly mechanical manner. We have seen promising power stations ruined from want of attention to this point. There is no occasion for dirt, dust, and smoky fumes in a gas producer house.

REVIEWS.

The A B C of the X-rays. By William H. Meadowcroft. New York: The American Technical Book Company, 45, Vesey Street.

Bibliography of X-ray Literature and Research (1896-1897) Edited by C. E. S. Phillips. *The Electrician* Printing and Publishing Company, Limited.

The literature of the X-ray appears to share the rapid progress of research in the new science. The earlier text-books on the subject have usually consisted of an accumulation of undigested and unverified abstracts from technical journalistic literature; some later books, however, by experts who are thoroughly acquainted with both the theory and practice of the subject are of a much superior quality.

The first of the volumes cited above appears to be tainted with the defects of premature birth. Mr. Meadowcroft states in his introductory chapter that the main object of his book is to give a practical explanation of the apparatus and methods employed in producing and utilising the X-rays, and if he had confined himself to this, we probably should have had few faults to find with his little book. It is when the author becomes more ambitious, as in his attempt to explain the action of the induction coil, that he comes to grief. For example, he says, in reference to the condenser, that its office "is to accumulate temporarily a charge of electricity upon the rupture of the primary circuit, and when stored to its full capacity to discharge a current suddenly and quickly, thus adding to the high potential output of the coil." As a matter of fact, in a well constructed coil, the discharge of the condenser produces no discharge at all between the terminals of the secondary; such a discharge (if it took place), being opposite in direction to the initial discharge, would be highly objectionable in the working of a single focus tube. This is merely a sample of many simpler blunders and confused statements made by the author in discussing the theory of the induction coil. Few things are of more importance to the student of X-rays than to understand thoroughly the working of his coil and the nature of its discharge, and we do not think we exaggerated

"ELECTRICAL REVIE

HIGH PRESSURE ALTER

PLACE.	Lighting Authority.	System of Distribuion.	Boilers.	Engines or Turbines and H.P. of each unit.	Type of Generators.	Size of Generators.	System of Driving.	System of Mains.	Number of Arc and Incandescents used in Private Lighting.	Nu Lamp Stree A Inca
PROVINCIAL.										
(1) **Aberystwyth** ..	Bourne and Grant Elecy. Co.	High pressure to house transformers	2 Economic	3 vert. com. (Browett-Lindley) 75 i.h.p. each, 1 of 53 i.h.p.	2 Johnson - Phillips and 2 Brush arc	2 50 kw., 2 55 lighters	Rope and belt	B.I.W. and Fowler-Waring lead cov. and arm'rd conc.	11 arcs and equivlts. of 2,500 8 c.p.	28 a
(2) **Altrincham**	Altrincham Elec. Supply Co., Ltd.	Transformer Sub stations	3 Lanc. ..	1 200 h p., 2 100 h.p., 1 50 h.p.	4 Manchester Edison-Swan..	1 120 kw., 2 60 kw., 1 30 kw.	Rope and belt	H.T. concen. feeders and H.T. concentric distribtrs.	19,000 8 c.p.	
(3) **Ayr**	Corporation	Transformer Sub-stations	Lanc.	2 horiz. 175 h.p. (Marshall), 1 vert. 50 h.p., 2 vert. 25 h.p., and 2 350 h.p. (Belliss) type	5 Siemens	2 200 kw., 1 100 kw., 1 25 kw.	Direct fly-wheel alternators	Callender's concentric	7,800 8 c.p.	30 a inc
(4) **Bath**	Corporation	Sub-station and house transformers	Water tube boilers	7 vert. (Brush) engines, 2 30 h.p., 1 70 h.p., 4 150 h.p	4 Mordey alternators, 2 T.H. arc lighters, and 2 300 k.w. direct alternators	4 75 kw., 2 300 kw.	Rope and direct	Callender's solid system	—	84 a
(5) **Bedford**	Corporation	Sub-stations and 3 wire distributors	6 water tube boilers	6 com. vert., 3 (Belliss) 55 h.p., 2 (Allen) 150 h.p., 1 (Allen) 260 h.p.	3 Johnson-Phillips, 2 Siemens, 1 Easton-Anderson	3 30 kw., 2 90 kw., 1 150 kw.	Direct ..	Rubber cables in iron pipes or conduits	13,000 8 c p.	340 la wi ca
(6) **Blackpool**	Corporation	Sub-station transformers	5 Galloway 2 Fraser's marine	1 400 h.p., 2 200 h.p., 2 100 h.p. (Fowler's), 1 500 h p., (Ferranti) 2 200 h.p. (Parsons' turbine), 1 100 h.p. (Parsons' turbine)	Leeds and London, Ferranti, E.C.C., and Parsons'	1 300 kw., 1 200 kw., 2 100 kw., 3 50 kw., 2 125 kw.	Rope and direct	Paper cbls. laid in wooden troughs	30,286 8 c.p.	143
(7) **Bolton**	Corporation	Sub-stn. trns., accmltrs. for motor genrs.	5 Lanc. ..	Inv. vert. com. 3 350 i.h.p., 2 200 i.h p., 1 100 i.h.p.	Mordey and Ferranti	3 200 kw., 2 100 kw., 1 50 kw.	Ropes and direct	Rub. concen. fdrs., jute arm'rd distrs. B.I.W. for both.	27,000 8 c p.	5 ar
(8) **Bournemouth** ..	Bournemouth & Dist. Elecy Supply Co.	Sub-station transformers	—	8 (Brush) engines	Mordey	1 150 kw., 2 100 kw., 4 50 kw., 1 30 kw.	Ropes and direct	Arm'rd concntrc. in ground, unarm'rd concntrc. in pipes	25,000 8 c.p	Non
(9) **Bray**	Town Commissioners	Sub-stations and house transformers	1 Davey-Paxman loco., 1 Lnc (Tinkr's)	1 120 i h.p (Brush), 1 120 (Robey), 1 130 (Easton - Anderson), 2 (Victor turbines)	Kapp and Easton-Anderson-Goolden	2 60 kw. (Kapp), 1 75 (E.A.G.)	Belts and direct	Lead covered concentric laid in ground	2,000 8 c.p.	30 127 25 c
(10) **Brighton**	Corporation	Alternating supply from sub-stations	6 Lanc., 3 B.W. water tube	2 80 h p. (Willans), 2 200 h p. (Willans), 4 360 h.p. (Willans), 1 750 h p. (Willans)	1 multi-polar, 8 bi-polar	2 45 kw., 2 120 kw., 4 220 kw., 1 440 kw.	Direct ..	H.T. feeders, con-concentric cables L.T. fdrs. lead cvd. and arm'rd cables	74,306 8 c p.	257 72 des
(11) **Bristol**	Corporation	Sub-station trans. 3 wire distributors	Lanc.	Willans	Siemens	2 88 kw., 4 210 kw., 2 400 kw., 3 52 kw. for arc ltg., 2 52 kw. exci.	Direct ..	Arm rd lead concen in grnd.; distbrs., triple conctr. arc mains arm'rd	43,615 8 c.p.	105
(12) **Burton-on-Trent**	Corporation	Street transformers	3 Lanc.....	3 horiz. com., 140 h.p. each	Lowrie-Hall	3 70 kw. each	Rope ..	H.T. feeders, vul. rubber cables in c.i. pipes	7,400 8 c.p.	
(13) **Cambridge**	Cambridge Electricity Supply Co.	Sub-stats. and house trans., 3 wire distrs.	3 Lanc.....	4 (Parsons') turbines.....	Parsons	3 150 kw., 1 75 kw...	Direct ..	H.T. feeders, rub. cables in pipes, B.I.W. triple con. distributors	3 arcs, 19,941 8 c.p.	1 ar
(14) **Cardiff**.....	Corporation	Transformer sub-stations	5	5 vertical compounds, 2 60 h.p., 2 270 h p., 1 500 h.p.	4 Siemens' disc armature, and 1 Ferranti flywheel	2 40 kw., 2 180 kw., 1 300 kw.	Direct ..	Silvertown concentric, B.I.W. and Siemens'	14,136 8 c p.	52 a
(15) **Carlow**	Milford Electric Supply Co.	Transformer sub-stations	Water tube boiler	Belliss engine 110 i.h.p., 2 turbines 60 h.p., 1 water wheel 30 h.p.	E.C.C.	—	Belt	Overhead	2 arcs and 800 incandescents	13 a 50
(16) **Chagford**	Chagford and Devon Elec. Light Co.	—	—	Water Wheel	—	—	Belt	Paper cables	—	15 inc
(17) **Chatham**	Chatham, Rochester & District	*No*	*Details*	*Available.*						
(18) **Chelmsford**	Chelmsford Elec. Lighting Co.	Transformer sub-stations	2 Lanc., 1 water tube	2 (Willans) 140 h.p., 2 (Willans) 120 h.p., 1 (Peache) 40 i.h.p.	Crompton	2 80 kw., 2 70 kw., 1 20 kw.	Direct ..	Rub. cbls. H.T. in Doult'n cndts. L.T. in iron pipes	2 arcs 5,250 8 c.p.	21 a 30 ca
(19) **Cheltenham**....	Corporation	Transformer sub-stations	3 Galloway	2 (Willans) 80 h.p., 1 (Willans) 180 h.p., 2 (Belliss) 180 h.p.	Siemens	2 33 kw., 3 110 kw. (2 220 kw. in construction)	Direct ..	Armoured and unarmoured	11,700 8 c.p.	64 a
(20) **Coatbridge**	Scottish House to House Elec. Supply Co.	Transformer Sub-stations 2 wire	2 Lanc.....	3 vertical marine, 100 h.p. each	Mordey	3 50 kw.	Rope ..	H.T. con. & sngl. vul. rub., in c.i. pipes L.T. Callndr's. C.C.	—	8 ar
(21) **Coventry**	Corporation	Street transformer boxes	Lanc.	3 horizon. com. 100 h.p., 200 h.p., and 400 h.p.	Fowler & Co.	1 50 kw., 1 100 kw., 1 200 kw.	Rope ..	H.T. rubber in c.i. pipes, L.T. armoured concn.	8,500 8 c.p.	
(22) **Croydon**	Corporation	Transformer sub-stations	Davey-Paxman	Belliss engines	British Thomson-Houston ..	3 120 kw.....	Direct ..	Callender's concentric	—	46 a
(23) **Derby**	Corporation	Trans. Sub-stns., direct current for street ltg.	6 Lanc. ..	2 250 h.p. (Browett-Lindley), 3 100 h.p. do., 3 50 h.p. do, 3 30 h.p. do, 3 10 h.p. do.	Siemens' disc alternators and arc machines	2 150 kw. alt., 3 60 kw. do., 2 28 kw. do, 3 18 kw. arcs	Direct ..	H.T. con. jute, ld. cov, & arm'rd & con. in pipes, L.T. I.R. and paper	—	77 a c.p des
(24) **Dover**	Dover Elecy. Supply Co.	Transformers in street bxs.	Water tube	Open type vertical, 84, 138 and 175 i.h p.	Mordey	1 50 kw., 1 75 kw., 2 100 kw.	Direct ..	Silvertown concentric	9,300 8 c.p.	40 a
(25) **Dublin**	Corporation	House transformers	4 water tube 2 marine	1 (Willans) 400 h.p., 1 (Fowler) 400 h.p., 1 (Fowler) 100 h.p., 3 (Coates) 350 h.p., 3 (Brush) 60 h.p.	E.C.C., Fowler, British, Thomson-Houston	2 200, 3 150, 1 50 and 3 Brush arc lighters	Direct and rope	Vulcanised rubber cables	23,000 8 c.p.	81 a
(26) **Ealing**	Urban District Council	Sub-station transformers	4 Lanc. ..	Browett-Lindley, 895 h.p.	Siemens	2 131 kw., 2 60 kw., 2 28 kw., 3 18 k.w., 2 10 kw.	Direct ..	Armoured concentric cables	12,684 8 c.p	75 a inca
(27) **Eastbourne** ..	Eastbourne Electric Ltg. Co.	Street and house transformers	—	1 (Fowler) com. 250, 1 (Marshall) 200, 1 (Fowler undertype) 60, 1 ditto 50, 1 (Peache) 260	E.C.C. and Fowler	2 70 kw., 1 30 kw., 1 150 kw., 1 100 kw.	Both ..	Mostly rubber in iron pipes	18,830 8 c p.	25 a
(28) **Edinburgh**	Corporation	Isolated transformers	Marine	Willans 100 to 350 h.p.	Ferranti	60 to 225 kw.	Direct ..	Armoured cable and bare copper strip	112,850 8 c.p.	500 a
(29) **Exeter**	Corporation	Sub-station transformers	—	2 com. hori. 150 h.p., 1 do. 80 h.p. 1 com. vert. 200 h.p., 2 triple expansion 25 h.p.	Brush, Easton-Anderson and Thomson-Houston	2 75 kw., 1 50 kw., 1 100 kw., 2 30 arc lighters	Rope, belt and direct	Concentric arm'rd, laid in ground	20 arcs and 9,000 8 c.p.	33 a 65 des
(30) **Fareham**	Urban District Council	Sub-station and house transformers	—	1 com. horiz. 105 h.p., 1 vert. 75 h.p., 1 vert. 40 h.p.	Thomson-Houston	2 35 kw., 2 30 light arc machines	Belts and ropes	Ovhd. and Okonite cbls. & paper insltd. in stonewr. condts.	1,600 8 c.p.	27 a 85 des
(31) **Halifax**	Corporation	Sub-station transformers	4 Lanc	1 horiz. 100 i h.p., 2 horiz. 200 i.h.p., 1 horiz. 600 i h.p., 1 vert. 600 i.h.p.	E.C.C.	1 50 kw., 2 100 kw., 2 350 kw.	Rope and direct	Vulcanised rubber cables	42 arcs, and 15,000 8 c.p.	31 a inc cen
(32) **Hanley**	Corporation	Sub-station transformers	5 Lanc	2 com. con. 100 i.h.p., 2 com. con. 200 i.h p., 2 com. con. 25 i.h p., 1 com. con. 500 i.h.p.	Mordey, Ferranti, and Brush arcs	2 50 kw., 2 100 kw., 2 (Brush) arc 12 kw., 1 (Ferranti) 300 & exci.	Rope and direct	H.T. B.I.W. concentric, L.T.B.I. W. & Callender's	16,047 8 c.p.	30 a inc cen
(33) **Harrogate**	Corporation	Sub-station transformers	2 Lanc	2 250 h p., 1 50 h.p.	Ferranti	2 125 kw., 1 25 kw.	Direct	B.I.W. concentric cables	7,000 8 c.p. and few arc lamps	1 ar a fe as e
(34) **Hastings**	Hastings and St. Leonards Elec. Ltg. Co	Sub-stations and house transformers	3 water tube	3 200 h p., 1 200 h.p. (Raworth)..	Mordey	3 100 kw., 1 50 kw.	Rope ..	Concentric vulcanised in pipes	11,192 8 c.p.	52 ar
(35) **Huddersfield** ..	Corporation	Sub-station transformers	6 water tube 2 Lanc.	1 100 h.p., 2 200 h.p., 1 450 h.p., 1 550 h p., (Ferranti) and (Brush)	Mordey and Ferranti	1 50 kw., 1 100 kw., 1 140 kw., 1 250 kw., 1 300 kw.	Rope and direct	Rubber cables ..	37,500 8 c.p.	14 ar 54 des
(36) **Keswick**	Keswick Elec. Light Co.	House transformers	Lanc.	Engine and turbine	Kapp	2 30 kw.	Belt	Rubber and overhead	—	
(37) **Killarney**.....	Electric Ltg. Co.	Sub-station transformers	—	1 engine 60 h.p., 1 turbine 30 h.p., 1 water wheel 100 h.p.	Mordey Victoria	1 60 kw., 2 25 kw. ..	Ropes ..	H.T. con. armrd. and vulc. rub. in Doulton pipes	2,800 8 c p.	2 inc cen
(38) **Kingston-on-Thames**	Corporation	Sub-station transformers	3 Lanc. ..	8 (Belliss), 4 30 h.p., 1 40 h.p., 2 75 h.p., 1 150 h p.	Siemens	1 25 kw., 2 50 kw., 1 100 kw., 2 20 kw., 2 20 kw. exciters	Direct ..	Concentric steel-armoured cables	7,500 8 c.p., and 16 arcs	36 a 16
(39) **Larne**.....	Larne Electric Light Co.	House transformers	2 Lanc., 100 h.p. each	2 horiz., 100 h.p.	Mordey Victoria	2 40 kw.	Rope ..	Armoured, concentric	—	14 ar 19 des
(40) **Leeds**	Yorks. House to House Co.	Sub-stats. and house transformers	Lanc.	——	E.C.C., Fowler, and Ferranti	3 100 kw., rope drvn., 2 200 kw., rope drvn., 2 300 kw., direct	Rope and direct	Rubber cbls. in c.i. pipes, and paper cables concntrc.	45,000 8 c.p.	
(41) **Leicester**	Corporation	Sub-station transformers	—	3 horiz., 350 h.p., 1 horiz., 112 h.p.	Mordey	3 200 kw., 1 75 kw.	Direct	Concentric, lead covered, in pipes	100 arcs and 21,340 8 c.p.	
(42) **Lynton**	Electric Ltg. Co.	Sub-station transformers	—	Giant turbines, 150 h.p. (Pelton wheels), 150 h.p.....	Mordey and Lowrie Hall....	2 37½ kw., 1 150 kw.	Direct and belt	Callender and Silvertown in pipes	—	3,000 des arcs
(43) **Newcastle-on-Tyne**	Newcastle and Dis. Electric Lighting Co.	House transformers	—	Parsons' turbines	Parsons' turbo-alternators ..	75 to 150 k.w.....	Direct ..	Vulcanised rubber	—	10 ar
(44) **Newcastle-on-Tyne**	Newcastle Electric Ltg. Co.	Sub-stats. and house transformers	Lanc.	Robey horizontal, 1 800 h.p.	Mordey	950 kw.	Rope ..	Cables in iron pipes	40,000 8 c.p.	14 ar
(45) **Newport**	Corporation	Street and house transformers	4 Lanc. ..	4 com. 150 h.p., 1 com. 120 h.p., (Fowler)	Fowler	4 75 kw., 1 50 kw. ..	Ropes ..	Siemens' rubber cables	30 arcs, 13,676 8 c.p.	42 ar
( ) **Portsmouth** ..	Corporation	Street transformers	5 Lanc. ..	3 400 i.h.p., 1 (Parsons') turbo set 150 kw.	Ferranti and Parsons	3 212 kw., 1 150 kw.	Direct ..	Con., Jennings' con-	7 arcs,	264 a

VIEW" LIST OF ELECTRICIT

TERNATING CURRENT.

	Number of Arc and Incandescents used in Private Lighting.	Number of Lamps used in Street Lighting; Arc and Incandescent.	Number of C.P. Lamps added during past 12 months.	Price Charged to Private Consumers.	System of Charging.	Type of Meters Employed on Consumers' Premises.	Present actual Capacity of Works in kw.	Nature of Fuel used.	Total Cost of Constructing and Equipping Works.	Cost of Mains.	Annual Revenue per 8 C.P. Lamp.	Number of 220 volt Lamps used.	Engineer-in-Chief.	REMARKS.	PLAC
r-	11 arcs and equivlts. of 2,500 8 c.p.	28 arcs....	1,200 for last 9 months	8d.	Meter ..	Chamberlain-Hookham	—	Anthracite and coke	—	—	—	None.....	E. E. Putland..	High voltage lamps under consideration,	**PROVIN**
l-	19,000 8 c.p.	—	6,000....	6d.	..	Chamb'lain-Hookham & Thomson-Houston	270 kw.	Household Screenings	£20,937	£7,925	—	—	E. W. Cowan	Cost includes sums spent under Ashton and Mersey Order	(1) Aberdee
s.	7,800 8 c.p.	30 arcs, 95 incand.	3,650 in 6 months	6d. first hour, 4d. afterwards	Brighton	Thomson-Houston and Chamberlain-Hookham	525 kw	Dross	£40,000	£7,900	6/7	Introduction just commenced	Arthur J. Fuller		(2) Belfast.
d	—	84 arcs	—	6d.	Discounts to large consumers	Shallenberger....	900 kw.	Coal and liquid fuel	—	—	—	None	G. F. Metzger		(3) Bilston .
n r	13,000 8 c.p.	340 lamp cols. with 2 incan. in each	4,000....	6d.	—	Chamb'lain-Hookham and Shallenberger	420 kw.	Hard steam coal	£15,000	£24,000	7/-	None	W. J. Hope Johnston		(4) Birkenh
n	30,286 8 c.p.	143 arcs ..	6,896....	8d. first hour, 2d. after	Brighton	Shallenberger and Thomson-Houston	1,050 kw.	Bituminous coal	With extensions £80,000	£20,000	7/3	With one or two exceptns. used throughout	Robt. C. Quin		(5) Birming
,	27,000 8 c.p.	5 arcs	13,584 ..	6d. first hour, 3d. after	Brighton	Westinghouse, Thomson-Hston, Chmb'ln-Hook'm.	850 kw.	Coke b'ze 1/6 ton light lds., slck. 6, 9 hvy.	£60,000	£13,127	5/-	Intend changing over	Arthur Ellis		(6) Blackbu
in d s	25,000 8 c.p	None	2,400....	7d. and 5d. ..	Brighton	Thomson-Houston	600 kw.	Coke	—	—	—	Will be used for residential districts	F. W. Clements		(7) Bootle ..
a- a	2,000 8 c.p.	30 arcs and 127 incand 25 c.p.	282	8d	Meter and contracts	Shallenberger and Chamberlain-Hookham	195 kw.	Welsh Steam coal	£3,510 including mains	—	—	None	G. Marshall-Harriss		(8) Bradford
n- s d	74,300 8 c.p.	257 arcs and 721 incand-descents	18,000 ..	7d. first hour, 1½d. after	Brighton	Ferranti and Thomson-Houston	1 650 kw.	Welsh coal	£93,700	£83,000	8/9	Rarely used ..	Arthur Wright	Extensions in progress. Buildings arranged for 8,000 h.p.	(9) Brighous
n , c	43,615 8 c.p.	105 arcs ..	11,946 ..	Evening 6d, other times 4d., power 2d.	By meter and automatic clock	Thomson-Houston and Shallenbrgr.	2,076 kw.	Coal	£61,487	£51,672	8/8	None	H. Faraday Proctor	Capital does not include 2,400 kw. machines	(10) Brighto
n	7,400 8 c.p.	—	2,000....	6d.	Brighton system (in 1898)	Shallenberger ..	21 w.	Slack, coke, refuse from gas works	£30,000		4/9	None	F. L. Ramsden		(11) Bucking
, ,	3 arcs, 19,941 8 c.p.	1 arc.....	—	7d. for lighting and power, 3½d. for street ltg.	—	Shallenberger and Thomson-Houston	525 kw.	Coal dust..	£39,000		6/6	Few. Is to be partially adopted	John H. Barker		(12) Burnley
n l	14,136 8 c.p.	52 arcs	4,806....	6d. and 3½d for light, 3d. for power.	Brighton	Thomson-Houston, Shallenberger, and Ferranti	440 kw.	Steam coal	£49,523		8/10	None at present	N. Applebee ..		(13) Bury ..
	2 arcs and 800 incan-descents	13 arcs and 50 16 c.p.	140	—	Contract	—	135 kw.	—	—	—	—	None	J. Fincham		(14) Chester
	—	15 32 c.p. incandsnt.	—	10/- per 8 c.p. per annum	—	—	—	—	—	—	—	None	G. H. Reed....		(15) Dewsbu
															(16) Dundee
	2 arcs 5,250 8 c.p.	21 arcs, 240 30 c.p. incandes'nt	1,200....	6½d. with ½d. discount for cash	—	Mainly Thomson-Houston	320 kw.	Hard steam and Welsh	—	—	7/8	None	J. P. Nelson ..		(17) Edinburg
	11,700 8 c.p.	64 arcs	—	6d. to 3¾d. ..	Brighton	Mainly Thomson-Houston	396 kw.	Small coal	£19,030	£17,385	—	Extensions entirely on 200 volts	H. Kilgour	Extensions in progress	(18) Fort Wil
	—	8 arcs	—	7d. for first hour, and 3½d.	Brighton	Thomson-Houston	150 kw.	Washed single nuts	—	—	—	None	G. C. Laird....		(19) Galway
															(20) Glasgow
	8,500 8 c.p.	—	3,000....	6d. and 3½d.	Brighton	Chamberlain-Hookham and Thomson-Houston	350 kw.	Local coal	£16,178	£4,465	6/3	—	G. S Ram		(21) Gorseino
	—	46 arcs	12,000 ..	6d.	Sliding scale	Thomson-Houston	360 kw.	Welsh coal	—	—	—	Throughout system	T. Herbert Minshall		(22) Guildfor
	—	77 arcs, 4 50 c.p. incandescent	—	6d. for first 1½ hours, 3d. afterwards	Brighton	Thomson-Houston Shallenberger and Hookham	590 kw.	Hard steam coal	£58,650		—	—	J. E. Stewart		(23) Harrow-Hill
	9,300 8 c.p.	40 arcs	3,500....	7d. lighting, 5d. power	Brighton	Thomson-Houston	325 kw.	Welsh coal	£50,900	£16,758	9/4	—	A. A. Whitlock		(24) Hove ..
	23,000 8 c.p.	81 arcs	500	7d.	Sliding scale	Shallenberger....	—	Welsh coal	£58,000		8/-	None	Mark Ruddle ..		(25) Hull....
	12,684 8 c.p	75 arcs, 206 incandsnts	2,638....	6d. for lighting 4d. for power	Discount for cash	Thomson-Houston and Shallenberger	512 kw.	Pea and Welsh coal	£50,000	£25,668	—	None	J. Douglas Knight		(26) Kelvinsi
	18,880 8 c p.	25 arcs	2,700....	8d., and 4d. for power or heating	Discounts	Shallenberger and Chamberlain-Hookham	460 kw.	Welsh coal	—	—	—	—	H. W. Wilkinson		(27) Lancaste
	112,850 8 c.p.	500 arcs ..	41,300 ..	4d. for lighting and 2d. for power	Rebates up to 25 %	Ferranti and Shallenberger	3,110 kw.	—	—	—	6/5	230 v. lamps used throughout low tension system	Frank A. Newington	See also continuous current systems.	(28) Leaming
	20 arcs and 9,000 8 c.p.	33 arcs and 65 incan-descents	1,200....	6d., with scale to 4d.	On long hour consumption	Shallnbgr., Thomson-Houston and Hookham	320 kw.	Small Welsh coal	—	—	—	None at present	H. D. Munro ..		(29) Leyton .
	1,600 8 c.p.	27 arcs and 85 incan-descents	520	8d.	No discount	Shallnbgr., Thomson and Chamberlain-Hookham	80 kw.	Welsh coal	£3,000	£2,000	10/-	None	Arthur Blake ..		(30) Liverpoo
	42 arcs, and 15,000 8 c.p.	31 arcs, 42 incandes-cents	5,000....	5d. lighting, 2½d. power	Discounts	Thomson, and Chamberlain-Hookham	950 kw.	Yorkshire coal	£34,500	£14,800	6/9	New consumers	T. P. Wilmshurst		(31) Manches
	16,047 8 c.p.	30 arcs, 14 incandes-cents	4,097.... (during 1896)	5d. lighting, 3d. power	Brighton	Shallenbr., Chamberl'n-Hookh'm, Thomson	624 kw.	Slack	£25,809	£18,334	5/9	None	C. A. Cowell and C. J. Sutherland		(32) Mevagiss
	7,000 8 c.p. and few arc lamps	1 arc, and a few incd. as expmts.	—	6d.	Uniform charge	Thomson-Houston	275 kw.	Small coal	£25 000	£4,500	—	Only for large c.p.	G. Wilkinson..		(33) Middleto
	11,192 8 c.p.	52 arcs	1,878....	6d. and 1/- per 8 c.p. lamp demanded	—	Shallenberger, Chamberlain, and Thomson-Houston	350 kw.	Llangeneck Dust	—	—	—	Few, experimentally	L. Andrews....		(34) Nelson .
	37,500 8 c.p.	14 arcs, and 54 incan-descents	11,500 ..	6d. lighting, 2½d. power	Disct. according to consmptn.	Shallenberger, Thomson-Houston and Hookham	840 kw.	Slack	£39,000	£21,000	5/-	None	A. B. Mountain		(35) Northam
	—	—	—	—	—	—	—	—	—	—	—	—	--		(36) Norwich
	2,800 8 c.p.	2 incandes-cents	200	6d., and by contract	—	Chamberlain-Hookham	110 kw.	Slack	—	—	8/-	None	Wm. H. Joyce	Water power generally employed	(37) Nottingh
	7,500 8 c.p., and 16 arcs	36 arcs, 4 16 c.p.	2,050....	6d. and 4d. ..	Brighton	Thomson-Houston, Shallenberger, and Hookham	245 kw.	Small coal	£19,693	£9,799	9/-	None	J. E. Edgcome		(38) Ogmore
	—	14 arcs and 19 incan-descents	—	8d., but generally by contract	—	Shallenberger....	80 kw.	—	£11,000	—	—	None	M. G. Smyth ..		(39) Oldham
	45,000 8 c.p.	—	7,000....	5½d. to 6d. ..	Sliding scale	Shallenberger and Thomson-Houston	1,500 kw.	Local coal..	—	—	7/9	None	H. Dickinson ..		(40) Oswestry
	100 arcs and 21,340 8 c.p.	—	9,000....	5d.	No discount ..	Hookham and Shallenberger	675 kw.	Coke.....	—	—	6/-	None	A. Colson.....		(41) Pontypo
	—	3,000 incan-descents, 4 arcs	—	£1 per ann. per 16 c.p., or 5d. & 8d. per unit	—	Chamberlain and Hookham	225 kw.	—	—	—	—	—	J. H. Fooks-Bale		(42) Preston
	—	10 arcs....	5,000....	6d.	Discnt. up to 25 %	Shallenberger and Thomson-Houston	1,100 kw.	Small steam	£69,000	£16,700	6/3	—	W. D. Hunter..		(43) Richmon (S
	40,000 8 c.p.	14 arcs	5,000....	4½d.	Discount	Thomson-Houston	990 kw.	Small steam	—	—	—	None	R. C. Jackson..		(44) Rottingde
	30 arcs, 13,676 8 c.p.	42 arcs	5,992....	6d. lighting, 4d. power	Sliding scale	Shallenberger, Thomson, and Hookham	350 kw.	Abercarn small coal	—	£11,113	7/-	None	C. D. Copland		(45) St. Austell
	7 arcs,	264 arcs,	8,178....	4½d. lighting	—	Shallenberger									(46) Shrewsbur
															(47) Southampt
															(48) Stafford ..
															(49) Stretford a Old Traf

	Council	transformers				2 28 kw., 3 18 k.w., 2 10 kw.		tric cables	
(27) **Eastbourne** ..	Eastbourne Electric Ltg. Co.	Street and house transformers	—	1 (Fowler) com. 250, 1 (Marshall) 200, 1 (Fowler undertype) 60, 1 ditto 50, 1 (Peache) 260	E.C.C. and Fowler	2 70 kw., 1 30 kw., 1 150 kw., 1 100 kw.	Both ..	Mostly rubber in iron pipes	18,830 8 c
(28) **Edinburgh**	Corporation	Isolated transformers	Marine	Willans 100 to 350 h.p.	Ferranti	60 to 225 kw.	Direct ..	Armoured cable and bare copper strip	112,850 8 c
(29) **Exeter**	Corporation	Sub-station transformers	—	2 com. hori. 150 h.p., 1 do. 80 h.p. 1 com. vert. 200 h.p., 2 triple expansion 25 h.p.	Brush, Easton-Anderson and Thomson-Houston	2 75 kw., 1 50 kw., 1 100 kw., 2 30 arc lighters	Rope, belt and direct	Concentric arm'rd, laid in ground	20 arcs ar 9,000 8 c.
(30) **Fareham**	Urban District Council	Sub-station and house transformers	—	1 com. horiz. 105 h.p., 1 vert. 75 h.p., 1 vert. 40 h.p.	Thomson-Houston	2 35 kw., 2 30 light arc machines	Belts and ropes	Ovhd. and Okonite cbls. & paper insltd. in stonewr. condts.	1,600 8 c.
(31) **Halifax**	Corporation	Sub-station transformers	4 Lanc	1 horiz. 100 i h.p., 2 horiz. 200 i.h.p., 1 horiz. 600 i h.p., 1 vert. 600 i.h.p.	E.C.C.	1 50 kw., 2 100 kw., 2 350 kw.	Rope and direct	Vulcanised rubber cables	42 arcs, ar 15,000 c.p.
(32) **Hanley**	Corporation	Sub-station transformers	5 Lanc	2 com. con. 100 i.h.p., 2 com. con. 200 i.h.p., 2 com. con. 25 i.h p., 1 com. con. 500 i.h.p.	Mordey, Ferranti, and Brush arcs	2 50 kw., 2 100 kw., 2 (Brush) arc 12 kw., 1 (Ferranti) 300 & exci.	Rope and direct	H.T. B.I.W. concentric, L.T. B.I.W. & Callender's	16,047 8 c.
(33) **Harrogate**	Corporation	Sub-station transformers	2 I anc	2 250 h p., 1 50 h.p.	Ferranti	2 125 kw., 1 25 kw.	Direct	B.I.W. concentric cables	7,000 8 c. and fe arc lamp
(34) **Hastings**	Hastings and St. Leonards Elec. Ltg. Co	Sub-stations and house transformers	3 water tube	3 200 h p., 1 200 h.p. (Raworth)..	Mordey	3 100 kw., 1 50 kw.	Rope ..	Concentric vulcanised in pipes	11,192 8 c.
(35) **Huddersfield** ..	Corporation	Sub-station transformers	6 water tube 2 Lanc.	1 100 h.p., 2 200 h.p., 1 450 h.p., 1 550 h p., (Ferranti) and (Brush)	Mordey and Ferranti	1 50 kw., 1 100 kw., 1 140 kw., 1 250 kw., 1 300 kw.	Rope and direct	Rubber cables ..	37,500 8 c.
(36) **Keswick**	Keswick Elec. Light Co.	House transformers	Lanc.	Engine and turbine	Kapp	2 30 kw.	Belt	Rubber and overhead	—
(37) **Killarney**	Electric Ltg. Co.	Sub-station transformers	—	1 engine 60 h.p., 1 turbine 30 h.p., 1 water wheel 100 h.p.	Mordey Victoria	1 60 kw., 2 25 kw. ..	Ropes ..	H.T. con. armrd. and vulc. rub. in Doulton pipes	2,800 8 c p
(38) **Kingston-on-Thames**	Corporation	Sub-station transformers	3 Lanc. ..	8 (Belliss), 4 30 h.p., 1 40 h.p., 2 75 h.p., 1 150 h p.	Siemens	1 25 kw., 2 50 kw., 1 100 kw., 2 20 kw., 2 20 kw. exciters	Direct ..	Concentric steel-armoured cables	7,500 8 c.p and 16 arc
(39) **Larne**.....	Larne Electric Light Co.	House transformers	2 Lanc., 100 h.p. each	2 horiz., 100 h.p.	Mordey Victoria	2 40 kw.	Rope ..	Armoured, concentric	—
(40) **Leeds**	Yorks. House to House Co.	Sub-stats. and house transformers	Lanc.	——	E.C.C., Fowler, and Ferranti	3 100 kw., rope drvn., 2 200 kw., rope drvn, 2 300 kw., direct	Rope and direct	Rubber cbls. in c.i. pipes, and paper cables concntrc.	45,000 8 c.
(41) **Leicester**	Corporation	Sub-station transformers		3 horiz., 350 h.p., 1 horiz., 112 h.p.	Mordey	3 200 kw., 1 75 kw.	Direct	Concentric, lead covered, in pipes	100 arcs an 21,340 8 c.
(42) **Lynton**	Electric Ltg. Co.	Sub-station transformers	—	Giant turbines, 150 h.p. (Pelton wheels), 150 h.p.....	Mordey and Lowrie Hall....	2 37½ kw., 1 150 kw.	Direct and belt	Callender and Silvertown in pipes	—
(43) **Newcastle-on-Tyne**	Newcastle and Dis. Electric Lighting Co.	House transformers	—	Parsons' turbines	Parsons' turbo-alternators ..	75 to 150 k.w.....	Direct ..	Vulcanised rubber	—
(44) **Newcastle-on-Tyne**	Newcastle Electric Ltg. Co.	Sub-stats. and house transformers	Lanc.	Robey horizontal, 1 800 h.p.	Mordey	900 kw.	Rope ..	Cables in iron pipes	40,000 8 c.p
(45) **Newport**	Corporation	Street and house transformers	4 Lanc. ..	4 com. 150 h.p., 1 com. 120 h.p., (Fowler)	Fowler	4 75 kw., 1 50 kw. ..	Ropes ..	Siemens' rubber cables	30 arcs, 13,676 8 c.p
( ) **Portsmouth** ..	Corporation	Street transformers	5 Lanc. ..	3 400 i.h.p., 1 (Parsons') turbo set 150 kw.	Ferranti and Parsons	3 212 kw , 1 150 kw.	Direct ..	Con., Jennings' conduits, and B.I.W. concen.	7 arcs, 40,000 8 c.p
(47) **Prescot**	British Insulated Wire Co.	Sub-station transformers	2 Lanc. ..	2 com. 100 h.p., 1 com. 35 h.p. ..	Ferranti and Mordey	2 54 kw., 2 25 kw. ..	Rope....	B.I.W. paper cables	5 arcs an 1,800 i candesc'n
(48) **Reading**	Reading Electric Supply Co.	Sub-station and street transformers	3 Lanc. ..	3 200 h.p., 2 25 h.p.	Fowler	125 kw.	Direct ..	Callender's concentric	12,000 8 c.p
(49) **Rugby**	Rugby School Electric Ltg. Co.	House transformers	Dowson Gas Producers	Gas engines, 1 80 h.p., 1 65 h.p.	Brush, Nalder and Harrison	1 50 kw., 1 35 kw. ..	Belts....	Concentric, lead covered	2,910 kw. .
(50) **St. Helens**	Corporation	Sub-station transformers	Lanc.	Com. with fly-wheel alternators	Johnson Phillips	1 200 kw., 1 50 kw.	Direct ..	Concentric	6 arcs, 3,48 8 c.p.
(51) **Salford**	Corporation	Sub-station and house transformers	3 Lanc. ..	3 (Browett) com. 200 h.p. each ..	Mather Platt	3 120 kw.....	Ropes ..	Rubber cables and fibrous, arm'rd	20,000 8 c.p
(52) **Scarborough** ..	Scarborough Electric Ltg. Co.	Sub-station and house transformers	3 Lanc. ..	Parsons' turbines, 3 150 kw, 1 75 kw.	Parsons	3 150 kw., 1 75 kw.	Direct ..	Silvertown cables in c.i. pipes	19,624 8 c.p
(53) **Sheffield**	Sheffield Elec. Lighting and Power Co.	Sub-station transformers	Water-tube and Marine.	Compound and triple expansion engines	Brush and Ferranti	2 300 kw., 1 125 kw., 2 100 kw.	Ropes and direct	Paper and rubber cables	58,333 8 c.p
(54) **Southport**	Corporation	Sub-station transformers	4 Lanc.....	2 (Browett-Lindley) 100 h.p., 1 do. 50 h.p., 2 (Musgrave) 250 h.p 1 do. 500 h.p.	Mather and Platt and Ferranti	2 50 kw., 1 25 kw., 2 125 kw., 1 300 kw.	Ropes and direct	Paper, lead cov. and armoured concentric	18,800 ....
(55) **South Shields**..	Corporation	Sub-station transformers	Marine....	Triple expansion	Ferranti	1 15 kw., 2 100 kw., 2 200 kw.	Direct ..	H.T. rub. concen. L.T. paper and rubber	5,000 8 c.p.
(56) **Taunton**	Corporation	Sub-stats. and house transformers	—	1 (Belliss) 150 h.p., 2 (Willans) 135 h.p., 1 (Chandler) 50 h.p., 2 (Ruston Proctor) 75 h.p.	Thomson-Houston	1 90 kw., 2 70 kw., 1 30 kw., 4 30 arc light machines	Belt	Armoured concentric cables	7,500 8 c.p.
(57) **Tunbridge Wells**	Corporation	Sub-station Transformers	Water tube	Willans and Ferranti	Johnson and Phillips and Ferranti	1 400 kw., 3 80 kw., 1 40 kw.	Direct ..	Armoured concentric cables	16,000 8 c.p
(58) **Wakefield**	Corporation	Sub-station transformers	—	3 (Fowler) 180 h.p., 1 (Belliss) 50 h p.	Fowler.....	3 100 kw., 1 28 kw.	Direct ..	Armoured concentric	—
(59) **Wallasey**	Urban District Council	Sub-station & house transformers	3 Lanc.....	Compound vertical	Ferranti	2 75 kw., 1 200 kw.	Direct ..	B.I.W. armoured cable	4,500 8 c.p.
(60) **West Ham**	Corporation	Sub-station transformers	—	3 350 h.p., 1 120 h.p.	Ferranti	3 200 kw., 1 75 kw.	Direct ..	B.I.W. concentric	—
(61) **Woking**	Woking Elec. Supply Co.	Sub-statn. and street box transformers	—	Belliss 125 h.p. (Parsons) 125 h.p. 2 (Renshaw) 75 h p.	Parsons and Brush	2 75 kw., 2 37½ kw.,	Belt and direct	Vulcanised rubber cables	3 arcs, &c.
(62) **Worcester**	Corporation	Sub-stns. and house transformers	Water tube boilers	3 vertical marine engines, 286 i h.p. (Belliss) engine, 100 b.h.p., and 2 72-in. (Victor) turbines	Mordey and Ferranti	4 125 kw., 1 300 kw.	Ropes and direct	Brook's semi-solid B.I.W. or Callender's	15 arcs and 19,887 8 c.p.
(63) **Yarmouth**	Corporation	Sub-station transformers	4 water tube	1 300 h.p., 3 150 h.p., 2 60 h.p. ..	Crompton	1 150 kw., 3 75 kw., 1 15 kw., 4 15 kw. (arc lighters)	Direct and rope	Concentric, paper	9,800 8 c.p.
LONDON.									
(64) **City**.....	City of Lndn. Electric Ltg. Co.	Sub-station transformers	Chiefly water tube	Various types.....	Mordey, Ferranti, British T.H.	Various sizes	Direct and rope	Concentric cable .	280,000 8 c.p.
(65) **Hammersmith**	Vestry	Sub-station transformers	2 water tube, 1 Lanc.	3 (McLaren) 220 h.p., 1 (Belliss) 50 h.p.	Ferranti flywheel	1 25 kw., 3 125 kw..	Direct ..	Callender's concen. in c.i. pipes	6,540 8 c.p.
(66) **Hampstead**	Vestry	Sub-station transformers	4 Lanc., 2 Ellis-Eaves	2 (Willans) 290 h.p., 2 do. 145 h.p. 1 do. 30 h.p., 2 do. 29 h.p., 2 do. 22 h.p., 1 do. 500 h.p.	Siemens and Ferranti	2 200 kw., 2 100 kw., 1 20 kw., 2 18 kw., 2 13 kw., 1 350 kw.	Direct ..	Siemens', Glover's, and B.I.W. paper	49,747 8 c.p.
(67) **Islington**	Vestry	Street transformers	8 Lanc., 2 water tube	4 horiz. 250 i.h.p., 2 horiz. 500 i.h.p., 1 vert. 80 i.h.p.	Ferranti and Fowler.....	4 125 kw., 1 40 kw., 2 300 kw.	Direct and ropes	Rubber concentric	13,335 8 c.p.
(68) **Kensington**	House to H'se Electric Ltg. Co.	Sub-stats. and street transformers	—	4 (Fowler's) 180 h.p., 1 (Fowler's) 80 h.p., 2 (Willans) 250 h.p., 1 (Willans) 120 h.p., 2 (Willans) 350 h.p.	E C.C.	4 100 kw., 1 50 kw., 2 200 kw., 2 140 kw., 1 70 kw.	Direct and rope	Paper cables	62,128 8 c.p.
(69) **London**	Metropolitan Electric Supply Co.	Sub-station & house transformers	Water tube & marine	Willans, Allen, Hornsby, Parsons, etc.	Kapp, Johnson Phillips, Siemens, Latimer Clark, Parker, and Parsons	120 to 500 kw.	Direct and ropes	Paper and rubber cables	340,000 8 c.p.
(70) **London**	London Electric Supply Corporation.	Sub statn and house transformers	Water tube	Hick Hargreaves, and Plenty & Son.	Ferranti	—	Ropes and direct	Paper	—
(71) **St. Luke's and Clerkenwell**	Cnty. of Lndn. & Br'sh. Prov. Elec. Ltg. Co.	Sub-station transformers	12 water tube boilers	12 (Raworth) engines, 250 h.p. ..	Mordey Victoria, and E.C.C.	150 kw.	Direct ..	H.T lead cv. papr, con. in c.i. pipes, L.T. lead cv. bitumenised fibre	22,947 8 c.p.
(72) **Wandsworth** ..	Cnty. of Lndn. & Br'sh Prov. Elec. Ltg. Co.	Sub-station transformers	6 water tube boilers	6 Universal engines 250 h.p.	Mordey Victoria	150 kw.....	Direct ..	H.T. Arm'rd, con. rub. L.T. lead cov. bitumenised fibre	14,913 8 c.p.
(73) **Woolwich**.....	Woolwich District Elec. Light Co.	Sub-station transformers	3 Loco	1 vertical comp. 150 i.h.p., 2 vertical comp. 20 i.h.p., 2 (Parsons') turbines 100 kw.	E.C.C., Parsons & Swinburne	1 120 kw., 2 100 kw., 1 30 kw., 1 10 kw.	Direct and ropes	Rubber cables in c.i. pipes.	3,798 8 c.p.

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es		incandsnts		4d. for power	for cash	and Shallenberger		Welsh coal					Knight	
bber in es	18,880 8 c.p.	25 arcs	2,700....	8d., and 4d. for power or heating	Discounts	Shallenberger and Chamberlain-Hookham	460 kw.	Welsh coal	—	—	—	—	H. W. Wilkinson	
cable e copper	112,850 8 c.p.	500 arcs ..	41,300 ..	4d. for lighting and 2d. for power	Rebates up to 25 %	Ferranti and Shallenberger	3,110 kw.	—	—	—	6/5	230 v. lamps used throughout low tension system	Frank A. Newington	See also continuous current systems.
c arm'rd, round	20 arcs and 9,000 8 c.p.	33 arcs and 65 incandescents	1,200....	6d., with scale to 4d.	On long hour consumption	Shallnbgr., Thomson-Houston and Hookham	320 kw.	Small Welsh coal	—	—	—	None at present	H. D. Munro ..	
l Okonite per insltd. r. condts.	1,600 8 c.p.	27 arcs and 85 incandescents	520	8d.	No discount	Shallnbgr., Thomson and Chamberlain-Hookham	80 kw.	Welsh coal	£3,000	£2,000	10/–	None	Arthur Blake ..	
l rubber	42 arcs, and 15,000 8 c.p.	31 arcs, 42 incandescents	5,000....	5d. lighting, 2½d. power	Discounts	Thomson, and Chamberlain-Hookham	950 kw.	Yorkshire coal	£34,500	£14,800	6/9	New consumers	T. P. Wilmshurst	
W. con- L.T.B.I. llender's ncentric	16,047 8 c.p.	30 arcs, 14 incandescents	4,097.... (during 1896)	5d. lighting, 3d. power	Brighton	Shallenbr., Chamberl'n-Hookh'm, Thomson	624 kw.	Slack	£25,839	£18,834	5/9	None	C. A. Cowell and C. J. Sutherland	
	7,000 8 c.p. and few arc lamps	1 arc, and a few incd. as expmts.	—	6d.	Uniform charge	Thomson-Houston	275 kw.	Small coal	£25 000	£4,500	—	Only for large c.p.	G. Wilkinson..	
c vul- n pipes	11,192 8 c.p.	52 arcs	1,878....	6d. and 1/- per 8 c.p. lamp demanded	—	Shallenberger, Chamberlain, and Thomson-Houston	350 kw.	Llangeneck Dust	—	—	—	Few, experimentally	L. Andrews....	
bles ..	37,500 8 c.p.	14 arcs, and 54 incandescents	11,500 ..	6d. lighting, 2½d. power	Disct. according to consmptn.	Shallenberger, Thomson-Houston and Hookham	840 kw.	Slack	£39,000	£21,000	5/–	None	A. B. Mountain	
nd over-	—	—	—	—	—	—	—	—	—	—	—	—	—	
armrd. rub. in pipes	2,800 8 c.p.	2 incandescents	200	6d., and by contract	—	Chamberlain-Hookham	110 kw.	Slack	—	—	8/–	None	Wm. H. Joyce	Water power generally employed
steel- l cables	7,500 8 c.p., and 16 arcs	36 arcs, 4 16 c.p.	2,050....	6d. and 4d. ..	Brighton	Thomson-Houston, Shallenberger, and Hookham	245 kw.	Small coal	£19,693	£9,799	9/–	None	J. E. Edgcome	
con-	—	14 arcs and 19 incandescents	—	8d., but generally by contract	—	Shallenberger	80 kw.	—	£11,000	—	—	None	M. G. Smyth ..	
s. in c.i. d paper ncntrc.	45,000 8 c.p.	—	7,000....	5½d. to 6d. ..	Sliding scale	Shallenberger and Thomson-Houston	1,500 kw.	Local coal..	—	—	7/9	None	H. Dickinson ..	
, lead n pipes	100 arcs and 21,340 8 c.p.	—	9,000....	5d.	No discount ..	Hookham and Shallenberger	675 kw.	Coke.....	—	—	6/–	None	A. Colson.....	
and Sil- in pipes	—	9,000 incandescents, 4 arcs	—	£1 per ann. per 16 c.p., or 5d. & 8d. per unit	—	Chamberlain and Hookham	225 kw.	—	—	—	—	—	J. H. Fooks-Bale	
l rubber	—	10 arcs....	5,000....	6d.	Discnt. up to 25 %	Shallenberger and Thomson-Houston	1,100 kw.	Small steam	£69,000	£16,700	6/3	—	W. D. Hunter..	
iron	40,000 8 c.p.	14 arcs	5,000....	4½d.	Discount	Thomson-Houston	990 kw.	Small steam	—	—	—	None	R. C. Jackson..	
rubber	30 arcs, 13,676 8 c.p.	42 arcs	5,992....	6d. lighting, 4d. power	Sliding scale	Shallenberger, Thomson, and Hookham	350 kw.	Abercarn small coal	—	£11,113	7/–	None	C. D. Copland	
ngs' con- B.I.W.	7 arcs, 40,000 8 c.p.	264 arcs, 470 32 c.p., and 9 16 c.p.	8,178....	4½d. lighting, 2½d. power	—	Shallenberger, Thomson, and Hookham	435 kw.	Small bituminous	£60,000	£10,000	6/–	None	E. Price	
per cables	5 arcs and 1,800 incandesc'nt	23 arcs, 114 incand.	—	6d.	Sliding scale	Thomson-Houston, Chamberlain-Hookham	158 kw.	Steam coal	£12,000		—	—	G. H. Nisbett..	
con-	12,000 8 c.p.	—	3,500....	6d. lighting, 3d. power	Discounts	Chambrln.-Hookm. Thomson-Houston, Westinghouse	375 kw.	Coal	£22,000	£11,000	—	None	F. F. Yeatman	
lead	2,910 kw. ..	—	460	6d.	—	Shallenberger, and Chamberlain-Hookham	85 kw.	Coal and coke	£1,900		6/–	—	W. J. Ferguson	
.....	6 arcs, 3,480 8 c.p.	—	911	6d.	—	Various	250 kw.	Coke breeze and slack	£10,000	£2,000	—	—	S. Glover.....	
les and m'rd	20,000 8 c.p.	—	11,000 ..	4d. lighting, 2d. power	Sliding scale	Shallenberger and Thomson-Houston	360 kw.	Gas coke ..	£44,000	£15,000	—	1,300 16 c p. ..	C. L. Turner ..	
cables es	19,624 8 c.p.	—	2,145....	6½d. to 5½d.	Discounts	Hookham, Shallenberger, Thomson-Houston	525 kw.	Steam coal	£19,000	£13,628	—	None	G. S. Peck	
rubber	58,333 8 c.p.	—	15,000 ..	5d.	Discounts	Thomson-Houston	925 kw.	Hard slack	£54,534	£32,474	7/2	None	W. Johnson ..	
d cov. noured	18,800	43 arcs, 15 amp.	6,000....	7d., 4d., & 2d. for lighting, 4d. power	Brighton	Shallenberger, Thomson-Houston and Hookham	675 kw.	Slack	£26,100	£16,050	6/3	All outlying districts	C. D. Taite....	
oncen. r and	5,000 8 c.p.	32 arcs	—	7d. and 3d., 2d. power	Brighton	Thomson-Houston	215 kw.	Unscreened coal	£30,000	£5,000	—	New residential districts	J. A. Jeckell ..	
oncen-	7,500 8 c.p.	70 arcs and about 300 incandsnt.	—	6d. to 3½d. ..	Brighton	Thomson and Shallenberger	—	Welsh smokeless coal	—	—	—	Extensions	E. J. B. Thornhill	
oncen-	16,000 8 c.p.	41 arcs, 108 incandsnt.	12,000 ..	6d. and 4d. lighting, 3d. power	—	Westnghse., Chamb'lain-Hookham & Thomson-Houston	680 kw.	Welsh coal	£35,000	£10,000	7/–	All.....	H. L. P. Boot	
oncen-	—	10 arcs	—	6d.	Brighton	Westinghouse ..	328 kw.	Slack coal	£25,000	£3,857	—	Distribution entirely on 200 v.	J. K. Brydges..	
noured	4,500 8 c.p.	—	—	7d. to 5d.....	Sliding scale	Westinghouse ..	350 kw.	Coke.....	£17,500	£5,000	—	None	J. H. Crowther	
centric	—	88 Jandus's	—	6d. and 4d. ..	—	—	675 kw.	—	—	—	—	—	J. J. Steinitz ..	
rubber	3 arcs, &c.	100 incandescents	1,800....	8d.	No rebates	Shallenberger and Thomson-Houston	225 kw.	Welsh coal	—	—	—	None	A. J. Wheatley	
i-solid Cal-	15 arcs and 19,887 8 c.p.	55 arcs and 5 incandescent	—	6d. and decreasing.	Brighton	Hookham, Thomson-Houston	500 kw.	Large Welsh	£60,718 including mains	—	4/10¾	—	E. T. Ruthven Murray	
paper	9,800 8 c.p.	73 arcs, 3 50 c.p. incandescents	2,100....	6d. lighting, 3½ power	—	Shallenberger, Thomson, and Hookham	450 kw.	Coal and gas coke	£16,770	£7,200..	6/6	None	A. W. Ranken	
cable .	280,000 8 c.p.	494 arcs, Markets 33 arcs	—	8d.	Sliding scale	Shallenberger, Westnghs., British Thomson-Houston	—	Small coal	£712,887	£488,747	—	—	Frank Bailey ..	
con- pipes	6,540 8 c.p.	87 arcs	—	6d.	Brighton and Manchstr.	Chamberlain-Hookham and Thomson-Houston	400 kw.	Welsh coal	—	—	—	None.....	G. Gilbert Bell	
over's, paper	49,747 8 c.p.	51 arcs	16,231 ..	6d. lighting, 4d. power & day load	Brighton	Thomson and Shallenberger	682 kw.	Welsh coal	—	—	4/10¼	None	G. H. Cottam..	
centric	13,335 8 c.p.	192 arcs ..	1,963 6 months.	7d. to 4d., power & day supply 3½d.	Brighton	Chamberl'n-Hookham, Westinghouse, Thomson	1,160 kw.	Welsh coal	£130,000	£33,000	—	All extensions..	Albert Gay	
s	62,128 8 c.p.	—	11,323 ..	6d lighting, 5d. power	—	Westinghouse and Thomson-Houston	1,200 kw.	Anthracite	£86,721	£47,067	5/10	None.....	H. W. Bowden	
ubber	340,000 8 c.p.	—	—	6d.	Sliding scale	Thomson-Houston, Shallenberger, and Ferranti	—	—	—	—	—	Not many, but extending	A. H. Walton..	
.....	—	—	—	—	—	—	—	—	—	—	—	—	P. W. d'Alton..	
papr, pipes, v. bi- fibre	22,947 8 c.p.	—	11,189 ..	7d. first 2 hrs'. ltg. then 3d., 6d. first hr., then 2d pwr.	Brighton	Thomson-Houston	1,800 kw.	Small rough coal	£100,000	£65,000	9/–	—	A. J. Lawson ..	
, con. ad cov. l fibre	14,913 8 c.p.	—	—	7d. 1st 2 hrs.' ltg. then 3d., 6d. 1st hr's. pwr. then 3d.	Brighton	Thomson-Houston	900 kw.	Small rough coal	£60,000	£75,000	—	—	A. J. Lawson ..	
les in	3,798 8 c.p.	—	559	6d.	—	Hookham, Shallenberger and Thomson-Houston	370 kw.	Welsh coal	£14,237	£1,852	9/1	None	F. B. Spencer..	

EDISWAN INCANDESCENT ELECTRIC LAMP AND EVERY ACCESSORY CONNECTED WITH ELECTRIC LIGHT INSTALLATION.

Catalogues on Application.

ESTIMATES FREE.

CONNOLLY BROS., Ltd.,
MANCHESTER.
INSULATED WIRES AND CABLES.
BLACKLEY TAPE.

CITY WORKS OF THE UN

LOW PRESSURE CONT

PLACE.	Lighting Authority.	System of Distribution.	Boilers.	Engines or Turbines and H.P. of each unit.	Type of Generators.	Size of Generators.	System of Driving.	System of Mains.	Number of Arc and Incandescents used in Private Lighting.	N Lar Stre Inc
PROVINCIAL.										
(1) **Aberdeen**.....	Corporation	3 wire at 220 and 440 v.	6 water tube	2 (Willans) 38 h.p., 3 do. 80 h.p., 2 do. 200 h.p., 1 do. 390 h.p.	E.C.C., Holmes and Crompton	2 23 kw., 3 48 kw., 2 120 kw., 1 180 kw.	Direct ..	Bare copper, Callender and B.I.W.	27,000 8 c.p.	22
(2) **Belfast**.....	Corporation	3 wire	—	Gas engines, 2 60 h.p., 4 120 h.p., 3 150 h.p.	Siemens and Holmes	2 26 kw., 4 57 kw., 3 72 kw.	Direct and rope	Bare copper and insulated cable	21,000 8 c.p.	
(3) **Bilston**.....	Urban District Council	2 wire	2 loco., 1 Cornish	2 37 h.p., 1 50 h.p.	Brush, Paterson and Cooper and E.C.C	1 12 kw., 1 15 kw., 1 18 kw.	Rope....	Armoured	—	16
(4) **Birkenhead**	Corporation	3 wire at 460 and 230 v.	3 Lanc	3 (Willans) 80 i.h.p.	Crompton	3 50 kw.	Direct ..	Callender's	25 arcs and 2,982 8 c.p.	4 a
(5) **Birmingham**....	Birmingham Electric Supply Co.	3 wire	Lanc.	Willans	Crompton and E.C.C.....	—	Direct ..	Bare copper and Callender's, in c.i. conduits	—	
(6) **Blackburn**	Corporation	3 wire and alternating Sub-stations	3 Lanc.....	2 (Willans) 80 h.p., 2 do. 100 h.p., 2 do. 200 h.p., 1 (Belliss) 360 h.p.	Mather and Platt and Siemens	2 45 kw., 2 120 kw., 1 225 kw., 2 altng. 60 kw. each	Direct ..	L.T. rub. in c.i. conduits, alterng. feed. con. arm'rd	14,000	21 in
(7) **Bootle**	Corporation	2 wire	—	Bumsted and Chandler	——	3 23 kw.	Direct ..	—	—	
(8) **Bradford**.....	Corporation	3 wire at 460 and 230 v.	—	Willans	Siemens	60 to 380 kw.	Direct ..	Feeders armoured dist. arm'rd, laid in ground	600 arcs and 50,000 8 c.p.	8 a in
(9) **Brighouse**	A. B. Brook	2 wire	—	Gas engines, 1 18 h.p., 1 33 h.p., 1 49 h.p.	Kapp	1 12 kw., 2 18 kw. ..	Belt	Overhead.....	30 arcs, 600 incan. and 4 motors.	
(10) **Brighton**	See	high	pressure	alternating.						
(11) **Buckingham** ..	Buckingham Elec. Lgt. and Pwr. Sup. Co.	2 wire	Cochrane	2 horizontal, 1 semi-portable	Elwell-Parker, Goolden, Greenwood and Batley	2 9 kw., 1 10 kw., 1 40 kw.	Belt and counter-shafting	Overhead.....	—	
(12) **Burnley**	Corporation	3 wire	—	2 120 h.p., 1 250 h.p.	Elwell-Parker	2 90 kw., 1 120 kw.	Rope ..	Callender's, laid in ground	14,500 8 c.p.	3 Ja
(13) **Bury**	Corporation	3 wire	2 Lanc. ..	2 (Belliss) 210 h.p., 2 (Belliss) 38 h.p.	——	2 130 kw., 2 22 kw.	Direct ..	Rubber in c.i. and stoneware pipes	3,600 8 c.p.	4 ar
(14) **Chester**	Corporation	3 wire 420 v.	5 water tube	3 (Belliss) 150 h.p., 2 (Belliss) 450 h.p.	Parker	3 80 kw., 2 250 kw.	Direct ..	Callender's bitumen cables	13,000 8 c.p.	48 a
(15) **Dewsbury**	Corporation	3 wire 200 v.	Lanc.	2 (Willans) 180, 1 (Willans) 80, 1 (Willans) 55	Crompton	2 100 kw., 1 50 kw., 1 30 kw.	Direct ..	Armoured, lead covrd. in ground	7,155 8 c.p.	8 ar
(16) **Dundee**	Corporation	3 wire 200 volt.	3 Lanc.....	7 aggregating 1,000 h.p.	Siemens	40 kw., 80 kw., 100 kw.	Direct ..	Copper strip and rubber	—	8 ar
(17) **Edinburgh**	Corporation	See	high	pressure alternating.						
(18) **Fort William** ..	Fort William Elec. Light Co.	3 wire	—	2 (Gilkes) turbines, 60 h.p. each.	Laurence, Scott & Co.	45 kw. each.	Direct ..	Overhead and underground	3,000 8 c.p.	6 ar ca
(19) **Galway**	Galway Elec. Light Co.	2 wire	Dowson Gas Producer	Turbines and gas engines	Statter and Crompton	—	—	—	—	
(20) **Glasgow**	Corporation	3 wire	—	2 (Willans) 80 h.p., 2 (Willans) 150 h.p., 3 (Willans) 250 h.p., 6 (Willans) 350 h.p.	Latimer Clark Muirhead, and Siemens	2 48 kw., 2 92 kw., 3 154 kw., 6 225 kw.	Direct ..	Bare strip and rubber cable	104,124 8 c.p.	112
(21) **Gorseinon**.....	Electric Light Co.	2 wire	Vertical boiler	1 12 h.p.....	Elwell-Parker	24 kw.	Belt	Overhead.....	570 8 c.p...	28 inc
(22) **Guildford**.....	Guildford Electric Light Co.	3 wire 400 v.	—	3 40 i.h.p.	——	3 20 kw.	Direct ..	Armoured cables	16 arcs, 1,454 8 c.p.	
(23) **Harrow-on-the-Hill**	Harrow Electric Light & Power Co.	3 wire 410 and 220 v.	Water tube boilers	Willans	Crompton	3 60 kw., 1 23 kw. ..	Direct ..	Bare strip and Callender cables	5,000 8 c.p. and 6 arcs	
(24) **Hove**	Hove Electric Light Co.	3 wire 220 v.	2 Lanc., 2 water tube	3 (Willans) 100 h.p., 1 do. 250 h.p., 1 do. 350 h.p., 1 (Belliss) 150 h.p.	Crompton	3 60 kw., 1 154 kw., 1 90 kw., 1 222 kw.	Direct ..	Bare strip	26,000 8 c.p.	4 ar
(25) **Hull**.....	Corporation	3 wire	3 Dav'y-Paxman, 1 Amos-Smith	2 (Willans) 80 h.p., 2 (Willans) 200 h.p., 2 (Willans) 300 h.p. (2 200 h.p. temporary)	Siemens and Holmes	2 44 kw., 2 115 kw., 2 180 kw.	Direct ..	Bare strip and armoured con.	243 arcs, 30,704 8 c.p.	
(26) **Kelvinside**	Kelvinside Electy. Co.	2 wire	2 water tube	2 (Willans) 125 h.p.	Goolden	2 75 kw.	Direct ..	Callender's armoured	9,246 8 c.p.	
(27) **Lancaster**	Corporation	3 wire	3 Lanc. ..	1 (Willans) 200 h.p., 1 (Willans) 135 h.p., 1 (Willans) 60 h.p.	Brush	1 120 kw., 1 80 kw., 1 36 kw.	Direct ..	Callender's bitumen cable	9,261 8 c.p.	20 a 16 can
(28) **Leamington** ..	Midland Elec. Light and Power Co.	2 wire	Loco.	2 horiz. 250 h.p., 1 horiz. 30 h.p.	Chamberlain and Hookham	2 80 kw., 2 50 kw., 1 30 kw.	Ropes and belts	Callender's, in brick culverts	6,600 8 c.p.	
(29) **Leyton**	District Council	3 wire 300 v.	Gas generators	4 (Wells) gas engines, 60 b.h.p. ..	E.C.C.	4 35 kw.	Belts ..	Siemens' concen. in Doulton conduits	15 arcs, 3,500 8 c.p.	150 des
(30) **Liverpool**	Corporation	2 and 3 wire	Lanc.	Willans 300 h.p.	Siemens and E.C.C.	160 kw.	Direct ..	Callender's solid ..	58,000 16 c.p.	127
(31) **Manchester**....	Corporation	5 wire and 3 wire	12 Lanc. ..	14 400 h.p.	Bi-polar	14 240 kw.	Belts and direct	Bare copper in concrete culverts, vul. rubber in pipes	1,219 arcs, 133,426 8 c.p. incandescent	20 ar
(32) **Mevagissey**....	Veale & Co...	2 wire	Loco.	Semi-portable 30 h.p.	Crompton	26 kw.	—	Bitumen solid cbls. copper strip	—	
(33) **Middleton**.....	Middleton Elec. Lgt. and Power Co.	—	Lanc.	1 horizontal 20 h.p.	2 Thompson	—	Belt	Overhead and I.R. cables in pipes	8 arcs, 900 incandescent	
(34) **Nelson**	Corporation	2 wire	—	Willans	——	93 kw.	Direct ..	Lead covered vul. cable in c.i. pipes	5,108 8 c.p.	4 arc
(35) **Northampton**..	Northampton Elec. Light and Pwr. Co.	3 wire	3 Lanc., 1 water tube	3 (Scott) 120 h.p., 1 (Willans) 80 h.p., 1 (Belliss) 40 h.p., 1 (Willans) 160 h.p.	Crompton and E.C.C.	2 62 k.w., 1 72 k.w., 1 25 k.w., 1 44 k.w., 1 140 k.w.	Direct and ropes	Bare strip	8,014 8 c.p.	2 arc
(36) **Norwich**	Norwich Elec. Supply Co.	3 wire	—	3 (Willans) 100 i.h.p., 3 do. 135 i.h.p., 2 do. 200 i.h.p., 1 do. 300 i.h.p.	Norwich	6 30 kw., 3 81 kw., 2 125 kw., 1 187 kw.	Direct ..	Bare copper in culverts	174 arcs, 13,000 16 c.p.	
(37) **Nottingham** ..	Corporation	3 wire	6 Lanc. ..	3 (Willans) 60 h.p., 4 do. 134 h.p., 2 do. 360 h.p.	Siemens	—	Direct ..	Callender's	25,476 8 c.p.	8 arc
(38) **Ogmore Valley**	Ogmore Valley Elec. Lgt. & Power Co.	—	—	——	Wilson & Co., and J. C. Howell	—	Belt	Overhead wires ..	900 16 c.p.	164
(39) **Oldham**.....	Corporation	2 and 3 wire	3 Lanc. ..	2 (Willans) 60 h.p., 2 do. 100 h.p., 2 do. 200 h.p., 1 do. 360 h.p.	Charlesworth Hall, and Siemens	2 36 kw., 2 60 kw., 2 120 kw., 1 225 kw.	Direct ..	Bare strip and rub. and paper cables in iron pipes	15,763 8 c.p.	22 ar
(40) **Oswestry**	Oswestry Elec. Lgt. and Power Co.	2 wire at 220 v.	—	——	Parker and Brush	—	Ropes and direct	Callender's armoured cables	3,500 8 c.p.	
(41) **Pontypool**.....	Pontypool Elec. Lgt. and Power Co.	2 wire	—	2 (Willans) 60 i.h.p., 1 (Willans) 25 i.h.p.	Crompton	2 34 kw., 1 13 kw. ..	Direct ..	Copper strip, and Callender's armoured	11 arcs and 3,890 8 c.p.	
(42) **Preston**	Northern Elec. Lighting Co.	3 wire at 110 & 220 v., H.T. alternating	—	2 (Belliss) 54 h.p., 8 (Belliss) 100 h.p.	Westminster	2 37 kw., 8 66 kw., 2 16·5 kw. motor alternators	Direct ..	Bare strip cable in pipes and arm'rd H.T. concentric	22,000 8 c.p.	42 ar
(43) **Richmond (Surrey)**	Richmond Elec. Lgt. and Power Co.	3 wire	3 Marine ..	3 100 h.p., 2 60 h.p.	Latimer Clark Muirhead & Co.	3 67 kw., 2 45 kw. ..	Direct ..	Bare strip, and Henley and Silvertown cable	9,200 8 c.p.	
(44) **Rottingdean** ..	Electric Light Co.	2 wire at 80 volts	1 water tube, 1 Davey-Paxman.	1 (Browett) 25 h.p., 1 (Shanks) 8 h.p.	Crompton	—	Belt ..	Cables in pipes ..	500 8 c.p.	11 25
(45) **St. Austell**	Veale & Co...	2 wire	—	3 compound.....	Crompton, Veale & Co.	*No further details.*				
(46) **Shrewsbury** ..	Shropshire Electric Lgt. & Power Co.	3 wire at 200 and 400 v.	3 water tube	3 (Belliss) 50 i.h.p.....	Parker's	3 33 kw.	Direct ..	Callender's armoured cable	9 arcs, and 2,500 8 c.p.	
(47) **Southampton**..	Corporation	3 wire at 100 and 200 v.	Lanc., loco., and water tube	——	Crompton	—	Direct and rope	Bare strip	8,900 8 c.p.	
(48) **Stafford**	Corporation	3 wire	3 Lanc. ..	3 (Marshall)	E.C.C.....	3 66 kw.	Rope ..	Vulcanised rubber in Doulton conduits	7,000 8 c.p.	4 arc
(49) **Stretford and Old Trafford**	District Council	3 wire at 460 volts	—	6 horiz. 126 b.h.p.....	——	6 90 kw.	Rope ..	Insulated cables in troughs filled with bitumen	—	44 ar 94
(50) **Sunderland**....	Corporation	3 wire and H.T. altg.	3 Lanc. 2 water tube	2 (Willans) 50 h.p., 3 (Willans) 90 h.p. 2 (Belliss) 220 h.p. 1 (Belliss)	Holmes, Parker, and	2 26 kw., 3 50 kw., 2	Direct ..	Bare strip and	13,975 8 c.p.	

UNITED KINGDOM.

ONTINUOUS CURRENT.

	Number of Arc and Incandescents used in Private Lighting.	Number of Lamps used in Street Lighting. Arc and Incandescent.	Number of 8 C.P. Lamps added during past 12 months.	Price Charged to Private Consumers.	System of Charging.	Type of Meters Employed on Consumers' Premises.	Present actual Capacity of Works.	Nature of Fuel used.	Total Cost of Construct-ing and Equipping Works.	Cost of Mains.	Annual Revenue per 8 C.P. Lamp.	Number of 220 volt Lamps used.	Engineer-in-Chief.	REMARKS.
	27,000 8 c.p.	22 arcs	—	6d.	Brighton	Ferranti	610 kw.	Coke and coal	£40,000	—	—	Used exclusively	Alfred Blackman	
	21,000 8 c.p.	—	6,250....	7d. lighting, 4d. power	Discounts Brighton projectd.	Ferranti	500 kw.	Gas	£20,000	£15,000	6/2	Good many....	Victor A. H. McCowen	
	—	16 arcs	140	—	—	—	45 kw.	Coal	£3,000	£200	—	None	C. L. U. Wilson	
	25 arcs and 2,982 8 c.p.	4 arcs	1,274....	6d. lighting, 4d. power	Discounts	Ferranti	150 kw.	Slack	—	—	—	All.....	G. P. Shallcross	
	—	—	—	7d.	Sliding scale	—	—	—	—	—	—	—	J. C. Vaudrey..	
	14,000	21 arcs, 70 incand.	3,000....	6d. and 3d. ltg. 2½d. power	Brighton	Hookham, Ferranti, and Thomson	675 kw.	Slack	£35,000	£16,000	7/-	Used on out-skirts of L.T. area	A. S. Giles	Alternating for out-lying districts.
	—	—	—	—	—	—	69 kw.	—	£4,016	—	—	—	H. McCormick	
	600 arcs and 50,000 8 c.p.	8 arcs, 50 incandsnt.	10,000 ..	5d. lighting, 2½d. power	2½ discnt. and free lamps.	Thomson-Houston, Hookham, Ferranti and Bastian	2,000kw.	Coal	£80,000	£50,000	7/2	Used throughout	A. H. Gibbings	
	30 arcs, 600 incan. and 4 motors.	—	—	5d.	—	Edmundson.....	50 kw.	Gas	—	—	—	—	A. B. Brook....	
	—	—	—	7½d. lighting, 6d. power	—	Hookham and Ferranti	68 kw.	Coal	—	—	—	None	Messrs. Gillies and Hornidge	
	14,500 8 c.p.	3 Jandus ..	2,500....	5d. lighting, street light-ing 3d.	—	Ferranti and Thomson	300 kw.	Slack	£19,703	£6,656..	5/10	Few	W. R. Wright	
	3,600 8 c.p.	4 arcs	—	6d. and 3d. lighting, 2½d. power	Brighton	Hookham	304 kw.	Slack	£16,000	£6,000..	—	Mostly.....	S. J. Watson ..	
	13,000 8 c.p.	48 arcs	—	6d.	—	Ferranti	740 kw.	Gas coke ..	£45,000	£10,000	—	All	F. Thursfield ..	
	7,155 8 c.p.	8 arcs	1,600....	6d. lighting, 3d. power	Brighton	Ferranti and Hookham	280 kw.	Fire nuts ..	£17,215	£6,415..	9/3	Half total num-ber installed	J. B. Mitchell..	
	—	8 arcs.	2,800....	4½d. lighting	—	Ferranti	750 kw.	Wallsend dross	£25,000	£12,000	—	All connections since 1896	Walter H. Tittensor	
	3,000 8 c.p.	6 arcs, 52 in-candesnt.	2,000....	9d. or 4½d. ..	Norwich	Scott's	90 kw.	—	£8,500		—	150 volt lamps throughout	J. Reed	
	—	—	—	—	—	—	—	—	—	—	—	—	J. Perry	
	104,124 8 c p.	112 arcs ..	24,984 ..	6d. first hour, 2½d. after-wards	Brighton	Ferranti	2,092kw.	Coke.....	£55,401	£70,996	6/4	Large number..	—	
	570 8 c.p...	28 16 c.p. incandsnt.	100	1/- per candle per annum	—	—	24 kw.	Bituminous coal	£1,000..	£200 ..	8/-	—	David Powell..	
	16 arcs, 1,454 8 c.p,	—	—	8d.	Discounts	—	60 kw.	Welsh coal	£4,073	£2,273	—	All.....	J. M. V. Money-Kent	
	5,000 8 c.p. and 6 arcs	—	2,500....	8d. lighting, 5d. power	—	Ferranti	203 kw	Welsh coal	£8,000	£10,000	—	—	W. C. C. Hawtayne	
	26,000 8 c.p.	4 arcs	—	8d.	Brighton	Ferranti	650 kw.	Welsh coal	£30,400	£32,800	6/2	5,000.....	C. Bottomley Smith	
	243 arcs, 30,704 8 c.p.	—	9,273....	6d. lighting, 3d. power	Brighton	Hookham and Ferranti	1,160kw.	Steam coal	£26,374	£21,210	—	A large number	A. S. Barnard	
	9,246 8 c.p.	—	1,282....	6d. lighting, 3d. power	—	Kelvin and Ferranti	150 kw.	Screened nuts	—	—	3/7	None	A. D. Brigham	
	9,261 8 c.p.	20 arcs, 36 16 c.p. in-candesc'nt	2,500....	5d. lighting, 4d. power	5 % disct.	Hookham	240 kw.	—	£22,984	£9,500	4/11	80	C. M. Johnston	
	6,600 8 c.p.	—	600	8d. to 5d.	—	Hookham	290 kw.	Coal	—	—	6/2	—	F. W. E. Jones	
	15 arcs, 3,500 8 c.p.	150 incan-descent	2,200....	5d. lighting, 3d. power	Discount	Ferranti and Thomson	140 kw.	Welsh Anthracite	£15,000	£10,000	—	150 volt lamps	H. C. Bishop ..	
	58,000 16 c.p.	127 arcs ..	30,000 ..	6d. and 4d. light'g, 3d. & 2d. power.	—	Hookham and Ferranti	6,500 h.p.	Slack	—	—	—	4,000 16 c.p. ..	A. Brom'ley Holmes	
	1,219 arcs, 133,426 8 c.p. incan-descent	20 arcs	40,834 ..	5d. or £7 per kw., installed and 1½d. unit consumed	Manches-ter	Ferranti, Thomson-Houston, and Aron	3,360 kw.	Washed slack	£168,196	£124,138	5/6	Few	C. H. Wordingham	
	—	—	—	—	—	—	—	—	—	—	—	—	Veale & Co. ..	
	8 arcs, 900 incandes-cent	—	—	—	By con-tract	—	66 kw.	Coal	—	—	—	—	R. D. Thompson	
	5,108 8 c.p.	4 arcs	860	5d. lighting, 4d. power	Discounts	Ferranti	100 kw.	Coal and Coke	£4,500	£5,600	5/6	None	Wm. Foster ..	
	8,014 8 c.p.	2 arcs	—	8d. and 4d. ..	Brighton	Hookham	409 kw.	Coal	£23,000		7/5	—	W. E. Heenan	
	174 arcs, 13,000 16 c.p.	—	8,000 ..	7d. and 3½d...	Norwich	Scott's	860 kw.	Coal	£29,450	£24,183	7/9	Outlying districts	F. M. Long....	
	25,476 8 c.p.	8 arcs	10,020 ..	6d. lighting, 3d. power	Brighton	Ferranti and Hookham	957 kw.	—	£67,387	£18,935	7/2	—	H. Talbot	
	900 16 c.p.	164 incand.	100	6d. and 8d. ..	—	Ferranti	40 kw.	Small coal	£5,000		8/9 and 12/6	None	—	
	15,763 8 c.p.	22 arcs	3,933....	4½d. & 3½d. ltg. 3d. street lgt.	Brighton	Ferranti	657 kw.	Slack coal	£24,204	£14,806	7/9	All.....	S. Wilmott Newington	
	3,500 8 c.p.	—	600	2d. motors 7d.	—	Hookham and Ferranti	90 kw.	Coal	£5,600		12/6	All.....	E. Bremner Smith	
	11 arcs and 3,890 8 c.p.	—	682	6d. lighting, 3d. power	—	Ferranti and Hookham	81 kw.	Small coal	£6,741	£1,051	5/0½	None	P. J. S. Tiddeman	Free wiring to consmrs using 20 units per ann. per 16 c.p.
	22,000 8 c.p.	42 arcs	—	7d. and 4d. ..	Brighton.	Thomson-Houston, Ferranti, and Hookham	635 kw.	Small slack	—	—	—	—	J. H. Tonge ..	
	9,200 8 c.p.	—	2,460....	7d.	—	Ferranti	291 kw.	Welsh coal	£18,663	£14,845	9/-	None	M. C. Flemyng	
	500 8 c.p.	11 25 c.p. ..	75	6d.	—	Ferranti	—	Welsh coal	—	—	—	—	W. J. Lidwell..	
	9 arcs, and 2,500 8 c.p.	—	1,500....	7d., 4d. and 2d.	Brighton	Thomson and Ferranti	99 kw.	Coal	£10,388	£5,640	7/3	To be changed over	Henry Conner	Undertaking to be purchased by Corporation.
	8,900 8 c.p.	—	2,000....	6d. lighting, 3d. power	Brighton	Ferranti and Hookham	—	Welsh coal	£28,424		8/7	1,000.....	J. H. Lee.....	
	7,000 8 c.p.	4 arcs	2,000....	7d. & 3d. ltg. 3d. power	Brighton	Hook'm, Ferranti, and Thomson-Houston	198 kw.	Coke breeze coke, and rough slk.	£18,695	£3,100	5/9	Very few	J. Ferguson Bell	
	—	44 arcs, and 84 32 c.p.	—	6d.	Brighton	—	540 kw.	Refuse and coal	£27,000	£6,817	—	Throughout the system	F. F. Bennett	

	Council		tors						
(30) **Liverpool**	Corporation	2 and 3 wire	Lanc.	Willans 300 h.p.	Siemens and E.C.C.	160 kw.	Direct ..	in Doulton conduits Callender's solid ..	3,500 8 c.p. 58,000 16 c.p.
(31) **Manchester**	Corporation	5 wire and 3 wire	12 Lanc. ..	14 400 h.p.	Bi-polar	14 240 kw.	Belts and direct	Bare copper in concrete culverts, vul. rubber in pipes	1,219 arcs, 133,426 8 c.p. incandescent
(32) **Mevagissey**	Veale & Co...	2 wire	Loco.	Semi-portable 30 h.p.	Crompton	26 kw.	—	Bitumen solid cbls. copper strip	—
(33) **Middleton**.....	Middleton Elec. Lgt. and Power Co.	—	Lanc.	1 horizontal 20 h.p.	2 Thompson	—	Belt	Overhead and I.R. cables in pipes	8 arcs, 900 incandescent
(34) **Nelson**	Corporation	2 wire	—	Willans	——	93 kw.	Direct ..	Lead covered vul. cable in c.i. pipes	5,108 8 c.p.
(35) **Northampton**..	Northampton Elec. Light and Pwr. Co.	3 wire	3 Lanc., 1 water tube	3 (Scott) 120 h.p., 1 (Willans) 80 h.p., 1 (Belliss) 40 h.p., 1 (Willans) 160 h.p.	Crompton and E.C.C.	2 62 k.w., 1 72 k.w., 1 25 k.w., 1 44 k.w., 1 140 k.w.	Direct and ropes	Bare strip	8,014 8 c.p.
(36) **Norwich**	Norwich Elec. Supply Co.	3 wire	—	3 (Willans) 100 i.h.p., 3 do. 135 i.h.p., 2 do. 200 i.h.p., 1 do. 300 i.h.p.	Norwich	6 30 kw., 3 81 kw., 2 125 kw., 1 187 kw.	Direct ..	Bare copper in culverts	174 arcs, 13,000 16 c.p.
(37) **Nottingham** ..	Corporation	3 wire	6 Lanc. ..	3 (Willans) 80 h.p., 4 do. 134 h.p., 2 do. 360 h.p.	Siemens	—	Direct ..	Callender's	25,476 8 c.p.
(38) **Ogmore Valley**	Ogmore Valley Elec. Lgt. & Power Co.	—	—	——	Wilson & Co., and J. C. Howell	—	Belt	Overhead wires ..	900 16 c.p.
(39) **Oldham**	Corporation	2 and 3 wire	3 Lanc. ..	2 (Willans) 60 h.p., 2 do. 100 h.p., 2 do. 200 h.p., 1 do. 360 h.p.	Charlesworth Hall, and Siemens	2 36 kw., 2 60 kw., 2 120 kw., 1 225 kw.	Direct ..	Bare strip and rub. and paper cables in iron pipes	15,763 8 c.p.
(40) **Oswestry**	Oswestry Elec. Lgt. and Power Co.	2 wire at 220 v.	—	——	Parker and Brush	—	Ropes and direct	Callender's armoured cables	3,500 8 c.p.
(41) **Pontypool**.....	Pontypool Elec. Lgt. and Power Co.	2 wire	—	2 (Willans) 60 i.h.p., 1 (Willans) 25 i h.p.	Crompton	2 34 kw., 1 13 kw. ..	Direct ..	Copper strip, and Callender's armoured	11 arcs and 3,890 8 c.p.
(42) **Preston**	Northern Elec. Lighting Co.	3 wire at 110 & 220 v., H.T. alternating	—	2 (Belliss) 54 h.p., 8 (Belliss) 100 h.p.	Westminster	2 37 kw., 8 66 kw., 2 16·5 kw. motor alternators	Direct ..	Bare strip cable in pipes and arm'rd H.T. concentric	22,000 8 c.p.
(43) **Richmond (Surrey)**	Richmond Elec. Lgt. and Power Co.	3 wire	3 Marine ..	3 100 h.p., 2 60 h.p.	Latimer Clark Muirhead & Co.	3 67 kw., 2 45 kw. ..	Direct ..	Bare strip, and Henley and Silvertown cable	9,200 8 c.p.
(44) **Rottingdean** ..	Electric Light Co.	2 wire at 80 volts	1 water tube, 1 Davey-Paxman.	1 (Browett) 25 h.p., 1 (Shanks) 8 h.p.	Crompton	—	Belt ..	Cables in pipes ..	500 8 c.p.
(45) **St. Austell**	Veale & Co...	2 wire	—	3 compound.....	Crompton, Veale & Co.	*No further details.*			
(46) **Shrewsbury** ..	Shropshire Electric Lgt. & Power Co.	3 wire at 200 and 400 v.	3 water tube	3 (Belliss) 50 i.h.p.....	Parker's	3 33 kw.	Direct ..	Callender's armoured cable	9 arcs, and 2,500 8 c.p.
(47) **Southampton**..	Corporation	3 wire at 100 and 200 v.	Lanc., loco., and water tube	——	Crompton	—	Direct and rope	Bare strip	8,900 8 c.p.
(48) **Stafford**	Corporation	3 wire	3 Lanc. ..	3 (Marshall)	E.C.C.....	3 66 kw.	Rope ..	Vulcanised rubber in Doulton conduits	7,000 8 c.p.
(49) **Stretford and Old Trafford**	District Council	3 wire at 460 volts	—	6 horiz. 126 b.h.p.....	——	6 90 kw.	Rope ..	Insulated cables in troughs filled with bitumen	—
(50) **Sunderland**....	Corporation	3 wire and H.T. altg.	3 Lanc. 2 water tube	2 (Willans) 50 h.p., 3 (Willans) 90 h.p., 2 (Belliss) 220 h.p., 1 (Belliss) 400 h.p.	Holmes, Parker, and Crompton	2 26 kw., 3 50 kw., 2 125 kw., 2 38 kw., motor alternator	Direct ..	Bare strip and Silvertown cable	13,275 8 c.p.
(51) **Whitehaven** ..	Corporation	3 wire	Lanc.....	6 (Willans) 60 h.p.	Crompton	6 35 kw.	Direct ..	I.R. cables in earthenware pipes and lead covered	4,304 8 c.p.
(52) **Windsor**	Windsor Elec. Installn. Co.	3 wire	Lanc.	1 (Peache) 200 i.h.p., 3 do. 100 i.h.p.	Siemens	—	Direct ..	Triple concen. armoured	22 arcs, 4,000 8 c.p.
LONDON.									
(53) **Chelsea**.....	Chelsea Electricity Supply Co.	3 wire	Water tube	Willans	E.C.C.	80 kw., 150 and 200 kw.	Direct ..	Callender's in bitumen or stoneware casings	91,200 8 c.p.
(54) **Kensington**....	Kensington & Knightsbrdg. Elec. Ltg. Co.	3 wire	Water tube	Willans 1,990 h.p.....	Siemens	50 and 150 kw.	Direct ..	Rubber cables in iron pipes and bare strip	131,600 8 c.p.
(55) **Notting Hill** ..	Notting Hill Elec. Ltg. Co.	3 wire	Water tube	Willans	Crompton	—	Direct ..	Cables and bare strip	27,500 8 c.p.
(56) **St. James's and other Parishes**	St. James's and Pall Mall Elec. Ltg. Co.	3 wire	Economic, Loco., and water tube	12 (Willans) 4,100 h.p.....	Siemens	—	Direct ..	Callender's. bitu., Siemens, bare copr. and B.I.W.	123,000 8 c.p.
(57) **St. Martin's**....	Charing ×, & Strand Elec. Supply Co.	3 wire at 100, 200, and 1,000 volts	10 watr. t'be. 5 marine	5 (Willans) 100 kw., 3 (Willans) 75 kw., 2 (Willans) 40 kw., 6 (Belliss) 250 kw.	Mather and Platt and Siemens	5 100 kw., 3 75 kw., 2 40 kw., 6 250 kw.	Direct ..	Callender's in casing and arm'rd.	100,000 8 c.p.
(58) **St. Pancras** ..	Vestry	3 wire, 110 and 220 volts	Water tube and Lanc.	Willans, Belliss, and Peache	Kapp and Crompton.....	50 to 80 kw.	Direct ..	Bare strip and armoured cable ..	59,693 8 c.p.
(59) **Westminster and St. George's**	Westminster Elec. Supply Corpn., Ltd.	3 wire	—	Willans, up to 360 i h.p.	E.C.C., Crompton, Siemens, and Goolden.	Up to 225 kw.	Direct ..	Armoured strip and casing	290,000 8 c.p.
PROVINCIAL.									
(1) **Bridlington**	Urban Dist'ct Council	Series	—	Otto gas engine 20 h.p.	Thomson-Houston series....	18 arc lighter	Belt	Silvertown laid in Archer conduit	—
(2) **Keynsham**.....	Westn. Count. Elec. Lgt. & Power Co.	Series parallel	2	1 12 h.p., 1 10 h.p.	Crompton, and Johnson-Phillips	1 9·5 kw., 1 12 kw., 1 6·5 kw.	Belt	Overhead	1,950 8 c.p.
(3) **Kingswood**	West'n Cnties. Elec. Lgt. & Power Co.	Series parallel	1 Economic	1 36 i.h.p.	——	1 12 kw., 1 7 kw., 1 2 kw.	Belt	Overhead.....	100 .....
(4) **Londonderry** ..	Corporation	Series	—	3 compound cond., 150 h.p.	Siemens	6 30 kw.	Belt	Steel armoured ..	—
(5) **Oxford**.....	Oxford Elec. Light Co.	Sub-station, motor trans.	4 Loco.....	3 vertical 150 h.p. 1 do. 200 h.p. 1 do. 600 h.p.	E.C.C.....	3 90 kw, 1 100 kw, 1 260 kw.	Ropes and belt	H.T. I.R. cables in iron pipes L.T. Callender's	30 arcs and 20,300 8 c.p.
(6) **Wallsall**	Corporation	Sub-station motor transformers	2 Lanc., 1 water tube	3 vertical, 125 h.p.	Parker	80 kw.	Direct ..	Arm'rd H.T. con. rub. in pipes, L.T. Callender arm'rd.	6,289 8 c.p.
(7) **Treeton**	Parish Council	Series	—	——	Brush	14 kw.	—	Overhead.....	—
(8) **Wolverhampton**	Corporation	Sub-station motor transformers	Lanc.	3 compound 250 h.p., 1 compound 120 h.p.	E.C.C. and Parker	3 140 kw., 1 70 kw..	Rope ..	Callender's solid..	11,500 8 c.p.
LONDON.									
(9) **Shoreditch**.....	Vestry	Sub-station motor trans.	Dust destrs. and water tube boilrs.	3 (Willans) 300 i.h.p., 3 do. 150 i.h.p.	E.C.C.....	3 165 kw., 3 70 kw.	Direct ..	Paper in Doulton conduits, rubber cables	—
(10) **Sydenham**	Crystal Pal. & Dist. Elec. Lighting Co.	Sub-station motor trans.	Loco.	Horiz. compound	E.C.C.....	90 kw.	Ropes ..	Lead covered in ground	14,500 8 c.p.

HIGH PRESSUR

Manufacturers of

DYNAMOS MOTORS

ALTERNATORS

RESISTANCES FUSES

SWITCHBOARDS

BRUSHES CABLES

&c., &c.

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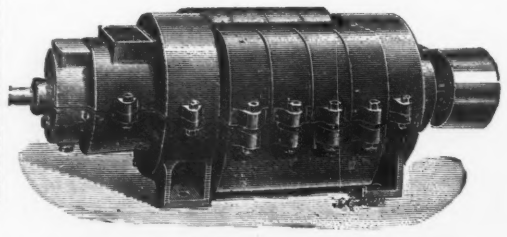
ENCLOSED MOTOR



FOR CONTINUOUS CURRENT.

CATALOGUES POST FREE ON Application.

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ELEC

EDISON & SWAN UNITED ELECTRIC LIGHT Co., Ltd.

con-	8,500 8 c.p.	descent		3d. lighting, 3d. power		Ferranti and Thomson	140 kw.	Welsh Anthracite	£15,000	£10,000	—	150 volt lamps	H. C. Bishop ..	
lid ..	58,000 16 c.p.	127 arcs ..	30,000 ..	6d. and 4d. light'g, 3d. & 2d. power.	—	Hookham and Ferranti	6,500 h.p.	Slack	—	—	—	4,000 16 c.p. ..	A. Brom'ley Holmes	
n con- s, vul. pes	1,219 arcs, 133,426 8 c.p. incandescent	20 arcs	40,834 ..	5d. or £7 per kw., installed and 1½d. unit consumed	Manchester	Ferranti, Thomson-Houston, and Aron	3,360 kw.	Washed slack	£168,196	£124,138	5/6	Few	C. H. Wordingham	
l cbls.	—	—	—	—	—	—	—	—	—	—	—	—	Veale & Co. ..	
l I.R. pes	8 arcs, 900 incandescent	—	—	—	By contract	—	66 kw.	Coal	—	—	—	—	R. D. Thompson	
vul. pipes	5,108 8 c.p.	4 arcs	860	5d. lighting, 4d. power	Discounts	Ferranti	100 kw.	Coal and Coke	£4,500	£5,600	5/6	None	Wm. Foster ..	
....	8,014 8 c.p.	2 arcs	—	8d. and 4d. ..	Brighton	Hookham	409 kw.	Coal	£23,000		7/5	—	W. E. Heenan	
in	174 arcs, 13,000 16 c.p.	—	8,000 ..	7d. and 3½d...	Norwich	Scott's	860 kw.	Coal	£29,450	£24,183	7/9	Outlying districts	F. M. Long....	
....	25,476 8 c.p.	8 arcs	10,020 ..	6d. lighting, 3d. power	Brighton	Ferranti and Hookham	957 kw.	—	£67,387	£18,935	7/2	—	H. Talbot	
es ..	900 16 c.p.	164 incand.	100	6d. and 8d. ..	—	Ferranti	40 kw.	Small coal	£5,000		8/9 and 12/6	None	—	
rub. ables s	15,763 8 c.p.	22 arcs	3,933....	4½d. & 3½d. ltg. 3d. street lgt. 2d. motors	Brighton	Ferranti	657 kw.	Slack coal	£24,204	£14,806	7/9	All.....	S. Wilmott Newington	
ables	3,500 8 c.p.	—	600	7d.	—	Hookham and Ferranti	90 kw.	Coal	£5,600		12/6	All.....	E. Bremner Smith	
, and ar-	11 arcs and 3,890 8 c.p.	—	682	6d. lighting, 3d. power	—	Ferranti and Hookham	81 kw.	Small coal	£6,741	£1,051	5/0½	None	P. J. S. Tiddeman	Free wiring to consmrs using 20 units per ann. per 16 c.p.
le in m'rd ntric	22,000 8 c.p.	42 arcs	—	7d. and 4d. ..	Brighton.	Thomson-Houston, Ferranti, and Hookham	635 kw.	Small slack	—	—	—	—	J. H. Tonge ..	
and ilver-	9,200 8 c.p.	—	2,460....	7d.	—	Ferranti	291 kw.	Welsh coal	£18,663	£14,845	9/-	None	M. C. Flemyng	
es ..	500 8 c.p.	11 25 c.p. ..	75	6d.	—	Ferranti	—	Welsh coal	—	—	—	—	W. J. Lidwell..	
able	9 arcs, and 2,500 8 c.p.	—	1,500....	7d., 4d. and 2d.	Brighton	Thomson and Ferranti	99 kw.	Coal	£10,388	£5,640	7/3	To be changed over	Henry Conner	Undertaking to be purchased by Corporation.
....	8,900 8 c.p.	—	2,000....	6d. lighting, 3d. power	Brighton	Ferranti and Hookham	—	Welsh coal	£28,424		8/7	1,000.....	J. H. Lee.....	
bber con-	7,000 8 c.p.	4 arcs	2,000....	7d. & 3d. ltg. 3d. power	Brighton	Hook'm, Ferranti, and Thomson-Houston	198 kw.	Coke breeze coke, and rough slk.	£18,695	£3,100	5/9	Very few	J. Ferguson Bell	
ables filled n	—	44 arcs, and 94 32 c.p.	—	6d.	Brighton	—	540 kw.	Refuse and coal	£27,000	£6,817	—	Throughout the system	F. F. Bennett	
and cable	13,275 8 c.p.	—	4,728....	5d. lighting, 2½d. power	Brighton	Ferranti and Thomson-Houston	452 kw.	Small coal	£28,697	£10,645	5/1	1,000.....	John F. C. Snell	Alternating for outlying districts
earth- s and	4,304 8 c.p.	437 incndsnt	288	5d	—	Hookham and Ferranti	210 kw.	Washed nuts	£7,213	£9,088	5/5½	Being tried for street lighting	C. M. Mayson..	
oured	22 arcs, 4,000 8 c.p.	—	4,176 ..	7d.	Rebates	Ferranti, Hookham and Thomson-Houston	—	Welsh coal	£13,000	£4,000	—	400 8 c.p.....	A. E. Farrow ..	
s in tone-	91,200 8 c.p.	—	18,000 ..	6d. lighting, 4d. power	Rebates to large cons'mrs.	Hookham and Ferranti	1,660 kw.	Welsh coal	—	—	5/10	All new connections	Percy Still	
es in and	131,600 8 c.p.	1 arc.....	22,619 ..	6d. at 100, 5d. at 200, 4d. power	Rebates	Aron, Ferranti and Hookham	1,500 h.p.	Welsh coal	£230,000		6/5	26,045	H. W. Miller ..	
bare	27,500 8 c.p.	—	2,000....	8d. at 100, 6d. at 200, 4d. day load	—	Ferranti and Hookham	800 h p.	Welsh coal	£31,107	£52,637	6/5	About 25% of connections	Geo. Schultz ..	
oitu., bare I.W.	123,000 8 c.p.	60 arcs	16,000 ..	6d. lighting, 4d. power	Rebates	Hookham, Ferranti, Aron, and T. H.	2,730 kw.	Coal	—	—	10/9	—	Sydney T. Dobson	
cas- 'rd.	100,000 8 c.p.	—	34,000 ..	6d. lighting, 4d. power	Sliding scale	Aron, Ferranti, Hookham, and T. H.	2,300 kw.	Welsh coal	—	—	—	Few, but increasing	W. H. Patchell	
d ar- e .. strip	59,693 8 c.p.	97 arcs. ..	8,550 16 c.p.	6d. and 3d. ..	Brighton, optional	Hookham, Ferranti and Thomson	2,810 i.h p.	Coal	£95,672	£74,689	9/4	A large number	Sydney W. Baynes	
strip	290,000 8 c.p.	—	45,000	6d. lighting, 4d. power	Rebates and discounts	Aron, Ferranti ..	—	Welsh coal	£250,000	£200,000	7/-	All new consumers.	Professor A. B. W. Kennedy.	

URE CONTINUOUS.

id in uit	—	16 arc, 2 32 c.p. incandescent	—	—	—	—	18 arcs	Gas	—	—	—	—	R. Railston Brown	
....	1,950 8 c.p.	12 50 c.p., 75 20 c.p.	350	6d.	—	Hookham	38 kw.	Coal	£3,500	£950	5/2	—	G. J. Parfitt ..	
....	100	150 incand.	—	6d.	—	Hookham	21 kw.	Coal	£1,300	£1,200	—	—	W. H. Bray ..	
d ..	—	185 arcs ..	—	—	—	—	180 kw.	Welsh coal	£20,000		—	—	J. Christie	
ables L.T.	30 arcs and 20,300 8 c.p.	32 arcs and 48 16 c.p.	3,100....	7d.	—	Hookham and Ferranti	630 kw.	Welsh coal	£47,808	£28,695	8/7	—	Percy J. Rea ..	
con. L.T. n'rd.	6,289 8 c.p.	14 arcs	585	6d. first 1½ hours, 2d. afterwards	Brighton	Hookham	240 kw.	Slack	£14,195	£6,376	6/2	None	A. Wyllie	
....	—	21 arcs	—	—	—	—	—	—	—	—	—	—	—	
id..	11,500 8 c.p.	51 arcs	2,800....	6d.	Brighton	Ferranti	482 kw.	Coal	£25,000	£8,400	8/10	None	F. Harman Lewis	
lton ober	—	57 arcs, 114 incand. 32 c.p.	—	6d. lighting, 3d. power, 2d. day load	Brighton	Ferranti and Hookham	705 kw.	Refuse and coal on Sundays	—	—	—	None	C. Newton Russell	
l in	14,500 8 c.p.	—	3,000....	6d. to 7d.....	—	Ferranti and Hookham	450 kw.	Welsh coal	—	—	6/3	—	A. L. Phillips	

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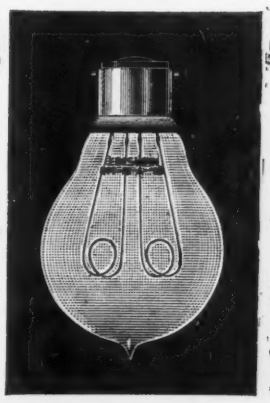

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the necessity for accuracy and clearness in the explanations of writers on this subject.

Mr. Meadowcroft's explanations of the working of high frequency apparatus and influence machines are much on a par with his remarks on the induction coil. He appears to think the only function of the condenser in the Tesla apparatus is to increase the frequency of the secondary discharge, and ignores the fact that it is equally effective in raising its potential. He confuses the action of the Tœpler with that of the Holtz machine, and the action of the Wimshurst with that of the Tœpler.

Mr. Meadowcroft wants to claim for America the credit of having invented the focus tube. He says that Prof. Elihu Thomson used a tube of this type as early as January, 1896, while it was only in April of the same year that the Jackson focus tube was announced in the English technical journals. If we are not mistaken, the first description of the E. Thomson tube appeared after the latter date, and if so it is remarkable, and not at all likely, that Prof. Thomson should have refrained so long from publishing so valuable a discovery.

There is a considerable amount of useful practical information in Mr. Meadowcroft's book, but all the same, it is a very misleading book to put in the hands of beginners.

The second of the works cited above is a very creditable attempt to collect into one volume references to all published matter on the Röntgen rays, from their discovery up to March, 1897. At the beginning of the volume is a very readable historical retrospect by the editor, Mr. C. E. S. Phillips. We object, however, to his giving Salvioni the credit of inventing the fluorescent screen, which was really discovered by Röntgen himself. Following the history is a chapter giving some valuable practical hints on the construction and working of Röntgen ray apparatus.

The bibliographical index is arranged on the mixed subject matter and name principle; repetitions of entries being avoided by a simple system of cross references. As far as we have tested the index it is fairly complete; though we also have noted that a few valuable papers and articles have failed to find any place in it. The unique work of Tesla, for example, is represented by two references, one to *Nature* and the other to *Electrical World*, N.Y., but it is well known Tesla's principal contributions to X-ray literature were published in the *Electrical Review*, N.Y. Salvioni's important paper on X-ray photometry is also omitted. The number of omissions we have discovered on a cursory examination is not, however, large. The short summaries given in some cases of the contents of articles, papers, &c., might, we think, be extended with advantage in a second edition. This little book should be of great value to all who are interested in X-ray literature and research, and ought to save much of the time and trouble expended in going over ground which has already been thoroughly explored.

Whittaker's Mechanical Engineers' Pocket-book. By Philip R. Bjorling. London: Whittaker & Co. 1898.

As its names implies, this is a pocket-book strictly for mechanical engineers, and more especially for those connected with works of water supply, and in place of the customary information in a civil engineer's pocket-book the place of this is filled with information about water, hydraulics being the author's specialty. Being published in New York, as well as London, much of the contents are referable to the U.S. gallon of 8·33 lbs. of water—this, we believe, being the old English wine gallon. We observe, also, references to a New York gallon of 8 lbs., possibly a relic of the Dutch occupation.

Hydraulic measurements are so often doubtful that there are numerous formulæ for water flow under varying conditions, and no one ever seems to be satisfied as to the even approximate accuracy of any of them. We have tested one from page 5, viz., Greenwell's rule for the flow of water from a bore-hole and find that when applied to an actual case which we ourselves measured with a large tank, it gives fairly accurate results.

The author bases all his pump formulæ upon the theoretical output. This is to be commended. Slip is so varying a quantity, and engineers know there is such a thing as negative slip, where more water can be passed through a pump than the volume described by the bucket.

In hand pumping, with a suction one-half the diameter of the barrel, very much larger supplies can sometimes be raised than can be accounted for by the diameter, speed, and maximum stroke. The skill of the man pumping has much to do with the result, which cannot so well be got by any crank motion. Generally speaking, there are some eight sections of the book dealing respectively with water and water power, wind power and air, gas engines, steam engines and boilers, and economisers, general mechanical details, mining machinery, measures and weights tables. There is a good deal, of course, that is antiquated in the book, for example, in the rules for gearing the old-fashioned long teeth are passed by just as though they were modern best practice; the author's proportions, however, being somewhat better than the majority. There is a good table of hyperbolic logarithms these being for every ·01 up to 10·00. A volume full of figures cannot be vouched for by a reviewer as correct, but if the few samples we have tested are a fair criterion of the whole not much fault can be found. We note that the symbol, J, is still kept at 772. While we do not quarrel with this, and scarcely care for the newer values of 778 known as Rowland's, we should like to know what scientific men generally are inclined to think should be the real value. Joule's value is said to be really 778 had he used the same thermometer as did Rowlands. However, this is a detail outside the scope of a pocket-book to consider. We can fairly recommend the book.

Students' Guide to Submarine Cable Testing. By H. K. C. Fisher and J. C. H. Darby. London: The *Electrician* Printing and Publishing Company.

This is a very good work compiled by practical men who have had considerable experience in cable testing. It is much upon the same lines as Kempe's Handbook of Electrical Testing (to which constant reference is made) in an abbreviated form; indeed, it may be said to stand midway between this work and that of Capt. Hoskær. A feature in the book is the very free use of numerical examples, which is of very material help to the reader. Many valuable remarks upon the methods of making the various tests are given.

Well printed, with plenty of good diagram figures, the book is just the thing for those interested in cable testing.

The Potentiometer and its Adjuncts. By W. Clark Fisher. London: The *Electrician* Printing and Publishing Company, Salisbury Court, Fleet Street.

It might be imagined that it would be hardly possible to make a book of 200 pages dealing with the potentiometer, but the contents of the book in question deals more with the adjuncts than with the instrument itself. Originally invented by Mr. Latimer Clark, a fact which seems almost to be forgotten, the potentiometer has always been one of the most useful as well as accurate measuring instruments devised. The book commences with a description of the Crompton pattern of the instrument, a pattern which is widely used and has many excellent points, especially as regards its wide range of applicability. In Chapter IV., dealing with "Galvanometers," only the D'Arsonval types are described, these being for electric light purposes the only form of galvanometer that can be used. There is something yet to be done in making these instruments perfect as they are by no means good "all-round" galvanometers, being sluggish in their action and consequently quite unsuitable for some classes of tests.

Chapter VI., on "Standards of E.M.F.," is very full, and describes the various forms of Clark cell, a cell which, although now a quarter of a century old, still continues to be the best yet devised for standard purposes. The common notion that unless a Clark cell is only used on practically open circuit it is quite unreliable, is shown to be quite an incorrect one; the Clark cell has remarkable recuperative properties, and will bear a good deal of rough handling in the form of short circuiting, without perceptibly altering its

E.M.F. Indeed, as the result of seven years' study, the author has come to the conclusion that constant use, with occasional short circuits are rather beneficial than otherwise. In chapters VII. and VIII. sub-multiples and multiples of standard resistances are described; for the sub-multiples manganin tubes, through which water circulates, appear to be satisfactory. An interesting chapter is that on "Resistance Alloys." Many excellent hints are given in the chapter dealing with "Erection of Apparatus." After giving full details upon the "Use of the Crompton Potentiometer," the book concludes with an "Historical" chapter and with chapters on "Bridges" "A Mechanical Potentiometer." Altogether the work is an exceedingly satisfactory and useful one.

CORRESPONDENCE.

The Electric Light Accident in Dublin.

I observe that in your last number you draw attention to a recent case before the Recorder's Court in Dublin, where a man obtained £20 damages from the Dublin Corporation for injury attributed to a shock from the electric light mains. The newspaper report of this case, from which you quote is, however, in several points entirely misleading. The "terrific shock" which the man swore he received did not arise from his coming in contact with the base of an electric arc lamp-post, but from treading on the iron plate over the manhole of the electric cables, which, with the return wire, were carried in an iron pipe bedded in the moist earth below. It was this "terrific shock" which I stated appeared to be "incredible" if the Board of Trade regulations were carried out, as was asserted to be the case; moreover, other passers by on the same spot, which is the corner of a usually crowded thoroughfare, did not appear to have suffered.

No one will dispute your assertion of "the danger of seizing hold of a man who is receiving an electric shock," provided the shock in the first instance be a dangerous one; and I need hardly say there is no foundation for the newspaper report of my having said anything to the contrary in the evidence I was asked to give in this case.

The case is certainly a curious one, and deserves further investigation, assuming, from the evidence given and from the judgment of the Recorder, that the man did receive a serious electric shock. Perhaps Mr. Ruddle, the able and experienced electrical engineer to the Dublin Corporation, who was on duty at the time of the accident and visited the spot where it occurred immediately afterwards, will contribute to your columns some of the particulars of this case, together with a sketch of the electrical arrangements at the place in question.

W. F. Barrett.

Royal College of Science, Dublin,
December 27th, 1897.

Dust Destructors.

I have lately been studying the question of dust destructors in combination with plant for the generation of electrical energy; and, in so doing, have not omitted the reading of the correspondence which appears weekly in the ELECTRICAL REVIEW professing to criticise the installation at Shoreditch.

From the standpoint of a student I cannot help regretting that the critics, anonymous and otherwise, have not condescended to be a little more explicit in the exposition of their views; that they are all in great pain is clear enough, but it is impossible to discover from their letters either the nature or the cause of their sufferings.

After very careful reading I am still unable to decide whether your correspondents' objections are to Shoreditch *per se*, to dust destructors, to electric lighting, to Alderman Kershaw, or to combinations of some or all of them.

So far as I understand the Shoreditch scheme, it has been well and carefully planned, and although it may not improperly be termed an experiment, it is only experimental as to the exact amount of the profit derivable therefrom.

To put the case broadly:—
Shoreditch is a parish governed by a vestry.
The Vestry is responsible for the removal of dust.
The removal of dust costs some money.
The destruction of dust costs less money.
The destruction of dust produces some heat.
Some heat will generate some electricity.
Ergo, There is some saving.

One letter contains an ill-defined suggestion that the capital expenditure has been increased by the combination of dust and dynamos, but no attempt is made to show how one chimney can be made to cost more than two, or how boilers combined with destructor cells can cost more than cells and boilers each having their own independent brickwork.

My own opinion is that such a combination should effect a considerable saving of capital expenditure.

It is quite evident from the correspondence that the primary duty of the installation is being well and effectually performed, for not only has the destructor dealt with the Shoreditch dust, but it has been able to lend a helping hand to neighbouring parishes; moreover, it appears to have provided surplus heat to the extent of the present requirement, viz., 250 kilowatts, with this exception, that when there was no dust, coal was burned, but obviously less coal than would have been used if there had been no dust at all.

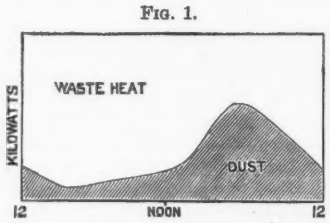
We have thus two conditions:—
(1) The destructor in full work.
(2) The electric plant in partial work.

If the electric plant were not working at all, there would be no saving under that head. As it is in partial work there is a partial saving.

The conditions of maximum saving may take some years to realise.

Diagram 1 shows present conditions; the parallelogram indicates the surplus heat produced in 24 hours; the shaded area shows the electrical energy generated by waste heat.

FIG. 1.



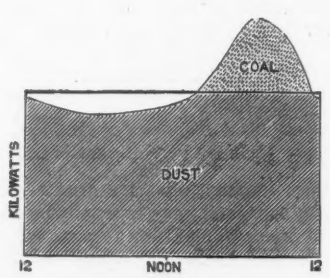


FIG. 2.

Diagram 2 shows the result which may be anticipated in the course of a few years.

While the electrical diagram lies wholly within the parallelogram the saving will be small; but when the electrical diagram shall entirely enclose the parallelogram the saving will be large. To determine the exact amount of the saving is the object of the experiment, for I take it that even the Shoreditch Vestry requires no demonstration of the proverb that "A penny saved is a penny gained."

I wonder how long it would take "Aunty Humbug" and "Ex-Wisehead" to get to Monte Carlo if someone would guarantee them against loss with 5 per cent. profit to boot? Aunty would leave her humbug at home, and Ex-Wise-

head would recover his wisdom instanter, and astonish even the Shoreditch Vestry.

But even Aunty and our converted Wisehead could not do better than Alderman Kershaw, who is playing for a possible 50 per cent., with a certain five. The name for this is "Velvet."

John Raworth.

December 24th, 1897.

P.S.—I find it impossible to resist the impression that your correspondents are either coal merchants or dust contractors: they have evidently some interest in discrediting the destructor, which interest would not be advanced by the disclosure of their names and callings.

I have watched with curiosity the columns of your journal, as I wished for further information *re* the above. I may say at once that this is my first letter on the subject, but all the same I thank Mr. Kershaw for his kind invitation to Shoreditch, and I shall not forget to pay a visit to that establishment on the first opportunity. I would, however, like to ask Mr. Kershaw one or two questions, and I hope that, for the public good, he will assist your readers so far as the answers go, and in return I shall be pleased to assist Mr. Kershaw any little that lays in my power.

I quite understand that the Chairman has been annoyed at the statements made in letters to the press *re* Shoreditch, and more particularly that they have been without signature; I consider the latter fact very unfair, for here is Dick, Tom, and Harry (as they will not sign themselves with their proper names), behind a wall blazing away at Mr. Kershaw, who, not knowing who they are, nor where situated, naturally sets up his back at such moonlight tricks. If the writers have reasons of their own for concealing their names, I consider Mr. Kershaw justified in refusing to answer their questions.

I believe Mr. Kershaw said, "What other towns can do we neither know nor care, but what Shoreditch is doing is quite another matter." Without doubt Mr. Kershaw is far more interested in Shoreditch than all the others put together, but I think in fairness to "other towns," who waited patiently or otherwise along with Mr. Kershaw to see the Shoreditch destructor scheme completed, and expected results proportionate to the outlay on the destructor plant, that they are not asking Mr. Kershaw to be ashamed of Shoreditch when they enquire, why are the Shoreditch results so low with such refuse as they have?

I have always understood that there existed a kind of freemasonry amongst municipal and vestry authorities in helping each other with any information in their possession, and no doubt, in the majority of cases it is so, and I am loth to believe Mr. Kershaw's vestry the exception. As to anyone being ashamed of Shoreditch, I give the Chairman credit for having done his best (and no one could do more), and that being so there is no need for shame, even if the scheme was an utter failure, which cannot be said of Shoreditch, I think. It is generally easy to be wise after the event, and no doubt Mr. Kershaw views your "Correspondence" columns through this kind of spectacles, but I think he might, by changing his glasses and his method, obtain, even through a correspondence column, some little item of information which would, if applied at Shoreditch, help to improve the result. No doubt the Chairman *would have been proud* had Shoreditch result been 1,000 kw. maximum load with the same proportion of accumulators as at present; and even now the case is not hopeless, but needs very careful handling to bring about the long expected result.

Hoping that Mr. Kershaw will throw some daylight into the matter by answering the following questions:—

What was the cost of the destructor house and contents, but not chimney?

How much refuse has been burnt this month, December (no doubt it will be the last day by the time this is printed)?

How much coal has been burnt during the month?

What is the actual output sold and used in public lamps for the month in kw. units; also total quantity generated?

Is it true that the thermal storage is not in use?

Please also state if the storage battery was in regular use during the month, if not, how long?

Sincerely hoping Mr. Kershaw will see his way to reply.

F. W. Brookman.

Rochdale, *December 24th*, 1897.

THE ENGINEERS' STRIKE.

It is a pity that the extensive freedom which seems to be the prerogative of trades union executives when fomenting a quarrel, shrinks to such very insignificant proportions when peace is the end aimed at, or supposed to be aimed at. Yet such seems to be the case. The collective bargaining so loudly claimed as being properly exercised by the men's executive on behalf of their members entirely fails when a Conference so loudly called for has at last been constituted by the Board of Trade. In place of a continuous Conference, negotiations have twice been broken off in order that the men, unfit to conduct individual bargain with their employers, and only safe in the hands of their executive, should have the opportunity of recording their opinion upon the terms arranged by their infallible executive. It looks as though the executive, having sown the wind, desire to shelter themselves from the whirlwind. The responsibility of continuing the strike is being adroitly shunted upon the shoulders of the men, and before long we shall see the executive assuming an air of virtuous pride, and assuring the men that the very excellent terms secured at the Conference have been rejected by the men's own ballot. The men have had to suffer all along, and now they will have to bear the blame for all the loss of the strike, which was entered upon without any proper appreciation of the economic facts. When it must have been obvious to the men's executive that the employers were fighting with their backs to the wall, common sense ought to have dictated more reasonable demands. Much mischief has been wrought by outsiders, whose ideas are altogether wrong. The mechanic is defined in Johnson's dictionary as a low mean fellow, and the parson-don element of society believes all workmen to be fighting hard for existence on pay insufficient to provide the scantiest necessaries of life. Such ignorance is inexcusable in men who ought to make it their business to know all the facts of sociology before rushing bareheaded into the fray. Let us take the case of Mr. George Cadbury, the cocoa manufacturer, who, reaping an immense fortune from what is practically a monopoly of a product which the public have been persuaded to believe has a food value, presents £50 or £100 per week to the strike funds. Apart from the value to him of this sum as an advertisement, Mr. Cadbury, if sincere, cannot have a knowledge of facts. If Mr. Cadbury believed in the justice of the men's cause, he would not allow those of his clerks who use black ink to write a single figure in red ink. If he were a practiser of what he pretends to preach by his weekly dole, he would insist upon all the type-writing machines he possesses being worked by members of the A.S.E. at 40s. a week. But Mr. Cadbury does not make his fortune out of such lack of business methods as this. He probably pays his type-writer girls the market rate. Many of them could very well do with a portion of the £50 he weekly lavishes on grown men who are refusing to work for good wages. We have no personal feeling against Mr. Cadbury; he has cared to make himself prominent in the matter, and we merely instance this gentleman, whom we have never seen, as an example of the outsider who is assisting to maintain a fight which can only end in disaster to his own side if victory falls that way. Trade unionism, to paraphrase a correspondence of *Commerce*, has become a secret society, whose aims are the destruction of capital; and these aims are followed irrespective of any consideration of foreign competition or of common sense. The carrying out of trades union ideas is illustrated by the case of the turner, who, when leaving his lathe at work while he ground a fresh tool, was informed by the shop delegate that he must not do two things at once. While grinding a tool he must stop his lathe.

In the absence of any agreement at the Conference, what are we to look forward to? We are told that the numbers of men drawing strike pay is decreasing. If this be so, it points to desertion of men from the union ranks and their return to work on the nine hours' day system. The men at work who are paying levies are, we believe, also decreasing. This points to resignations of men who are tired of these heavy levies, and have realised the loss of their old age pension fund. Defection will probably go on rapidly. Men to whom idleness is sweet, and whose family cares sit lightly upon them, will day by day form the larger portion of the out of works, and it may be that soon there will be no real strike and no lock out, but an army of pensioned idlers who will go pleasantly along on strike pay just so long as the keeping up of a semblance of strike suits the men's executive. The practical end cannot be far off. It seems to be inevitable to human nature and to mundane affairs that procrastination in huge changes when carried to extremes is only ended by a huge convulsion. The French Revolution was but the clearing up of arrears of unpleasant little changes.

The American Civil War was the aggregation of a host of delays incurred through the desire of people to put off the inevitable. The present strike seems likely to prove the overturn of the false system of procedure enforced for years by trades unions, and put up with by employers rather than incur unpleasantness at the time. The union demands grew by what they fed upon, and would soon have ruined English engineering trade. We have shown how the demands of the

men have checked production; have crushed the reason out of the masters' natural desire to follow Mr. Burn's advice, and "adopt improvements like the Americans"; have narrowed the margin of profit to the vanishing point. All these things have been visible in the future. Ruin has been seen advancing, but we have looked through the wrong end of the telescope and procrastinated; but this has not kept back the deluge. The floods have come and it is to be hoped will be powerful enough to end the old *régime* and leave a clear space for building up a new structure on a secure foundation. No longer can we govern our procedure by sentiment. The price of wheat is not governed by the desires of the grower so much as by the demands of the consumer, and the grower who cannot grow wheat at the market price, must drop out. England can and must do engineering work on modern lines. It has required a civil war to abolish slavery to the old methods, just as it required civil war to abolish slavery in the United States, though everyone really acknowledged to himself that the days of slavery had passed.

It is easy to see inside the secrets of the Trades' Executive. Practically their last report to the men was meant to secure a favourable answer to the masters' terms. But Mr. Barnes opens his mouth at Enfield and turns matters the other way and the strike goes on, and so also every day will see further lock-outs, and before long shops will be running full again and the men's places will be filled. The Conference has come to a lame and impotent conclusion, and we fear the men will regret it.

BUSINESS NOTICES, &c.

Universal Electrical Directory.—The proprietors beg to draw attention to the fact that the latest date for receiving subscriptions for the 1898 issue (at the reduced price of 4s.) is January 15th. After that date the price will be 6s.

Electrical Wares Exported.

Week Ending Dec. 28th, 1896.	£	s.
Alexandria. Teleg. mat.	80	0
„ Teleph. mat.	69	0
Amsterdam	74	0
Beira. Teleg. mat. ...	260	0
Bombay	142	0
Boulogne	12	0
Brest. Teleg. cable	33,000	0
Brisbane. Teleg. mat.	256	0
Buenos Ayres	215	0
Calcutta	175	0
Cape Town	517	0
Colombo	8	0
Demerara	23	0
Durban	887	0
Flushing	12	0
Hong Kong. Teleph. mat.	9	0
Launceston	116	0
Lisbon	191	0
Melbourne	180	0
Oporto	16	0
Ostend	124	0
Perth	40	0
Port Elizabeth	18	0
Port Said	16	0
Rangoon. Teleg. mat. ...	49	0
Rotterdam	31	0
„ Teleg. mat.	24	0
Shanghai	625	0
Singapore. Teleg. mat.	21	0
Sydney	2,173	0
Trinidad	125	0
„ Teleg. mat. ...	94	0
Wellington	3,382	0
Yokohama	137	0
Total	£43,101	0

Week Ending Dec. 28th, 1897.	£	s.
Antwerp	410	0
Brisbane	19	0
Buenos Ayres. Teleg. cable	990	0
Buenos Ayres. Teleg. wire	125	0
Calcutta...	213	0
Cape Town	136	0
Christiana	16	0
Colombo	25	0
Genoa	36	0
Melbourne	483	0
Natal	492	0
Port Elizabeth	312	0
„ Said	50	0
Reval	90	0
„ Teleg. mat. ...	300	0
Rotterdam. Teleg. mat.	30	0
Santos	52	0
Stockholm. Teleg. mat.	24	0
Sydney	395	0
Total	£4,198	0

A "Model Engineer."—To prevent any undue alarm, we might at once say that the *Model Engineer* is not a person but a new monthly journal, which is being published in the interests of amateurs. The full title of the excellent publication is the *Model Engineer and Amateur Electrician*, and in the first number are electrical articles written specially for the dabblers (we do not use this word disrespectfully) in the science.

Electrical Engineering in Portugal.—It is announced that an electric power transmission is about to be laid down at the Portuguese Government Dockyard in Lisbon, and that the contract for the supply of the necessary plant has been placed with two French firms.

Electrical Engineering in Switzerland.—Die Gesellschaft Electricitätswerk Lonza is the title of a company which has just been formed at Gampel (Wallis), with a capital of £32,000, to acquire and put down plant to utilise the Lonza waterfalls near Gampel.

Factory Act Prosecutions.—Last week at Manchester, before the stipendiary magistrate (Mr. Yates) Messrs. Dugdill, electricians, of Oldham Road, Failsworth, were summoned by Mr. E. S. Dawson, factory inspector, for employing a young person for more than seven days without the necessary certificate of fitness. On October 19th Mr. Dawson called at the defendants' works and found that a lad had been employed there about 12 months, though he had never been certified. The certificate was taken out a few days afterwards. The defendants said they had twice sent the lad to the doctor, but he could not meet with him. The firm were upset by moving at the time, and the matter had been overlooked. The defendants were ordered to pay the costs of the summons.—At the same court Messrs. S. B. de Ferranti, engineers, Hollinwood, were summoned for neglecting to fence certain dangerous machinery.—Mr. Dawson stated that on October 16th, a lad, aged 16, was assisting a workman to adjust a strap connected with a shaping machine. By some means the strap got off the pulley, and the boy in endeavouring to adjust it got his arm entangled, and was so injured that his right arm above the elbow had to be amputated. The shaft in question was about 4 feet 9 inches from the ground, and made about 150 revolutions per minute. He (Mr. Dawson) had previously pointed out to the defendants that the machinery should be fenced, and he believed they were carrying out his instructions at the time of the accident. He was instructed by the Department to take proceedings under Section 82, which gave the Bench power to inflict a penalty of £100, part of which could be used at the discretion of the Secretary of State.—Mr. Hockin, on behalf of the defendants, expressed their extreme regret that such an accident should have happened. The firm had recently removed from London to Hollinwood, where they employed between 500 and 700 hands. It had been a difficult matter removing from such a distance, but the fencing of the machinery was well in hand, and would be completed shortly. The defendants had paid the boy's father £50, £10 of which was to meet certain expenses and the other £40 to be invested for his benefit. In addition they undertook to retain him in their employ.—Mr. Yates said, considering that the defendants had so handsomely compensated the boy, he would impose a penalty for the breach of the Act of £5 and costs only.

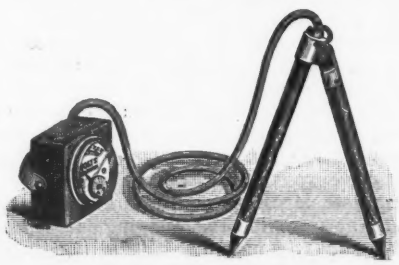
Glass Importers.—Messrs. Thomas H. Toy & Co. announce that on January 1st, 1898, they will commence business at 17, South Street, Finsbury, E.C., as importers and dealers in all descriptions of glass and metal supplies connected with the electric, gas, and oil trades.

Lecture Assistant Wanted.—A lecture assistant is wanted at the City and Guilds of London Institute, Exhibition Road. Further information will be obtained from our "Official Notices."

Messrs. Drake & Gorham's Staff.—Mr. W. Nelson, who for the past nine years has been chief draughtsman to the contract department of Messrs. Crompton & Co., Limited, has been appointed head draughtsman, which position recently became vacant by a recent resignation. We are asked to state that the firm protest against any claim of their late employés to having occupied posts other than that of head draughtsman and correspondent. The business is, and always has been, managed by the two working partners, who were trained, the one at Sir Joseph Whitworth's and the other at Messrs. Robey's. Owing to the continued increase of the firm's business, it has been found necessary to take still another suite of offices, which will be mainly devoted to the Jandus arc lamp department.

Personal.—Mr. Walter Mossop, who was for some years head of the electrical engineering department at Messrs. Osler's, previous to which he was in the employ of the Government of Malta, has now commenced work as a contractor, under the name of Messrs. W. Mossop & Co.

Portable Voltmeter.—The block illustrates a portable apparatus of the Edison-Swan Company for measuring the voltage of accumulators. The instrument has a spring control, so that it can be used in any position. It is fitted with a leather strap, which passes over the back of the hand, thus enabling the instrument to be held practically in the palm of the hand, whilst contact with the cells



is made by an adjustable fork, fitted with spears on each leg, which are pressed on to the lead poles of the cell. The spears are connected to the instrument by means of a flexible cord, covered in India-rubber tubing, and the whole of the instrument and spear is painted with a non-corrosive paint, so as to prevent damage by acid, vapours, &c. By means of this apparatus the separate voltage of a whole battery of accumulators can be quickly and accurately ascertained.

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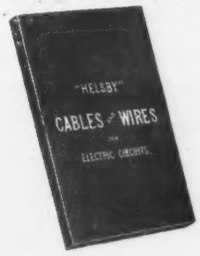

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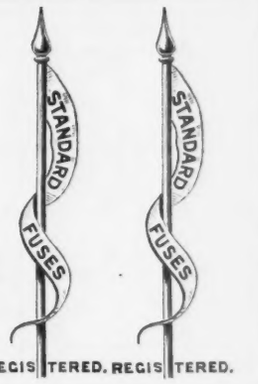

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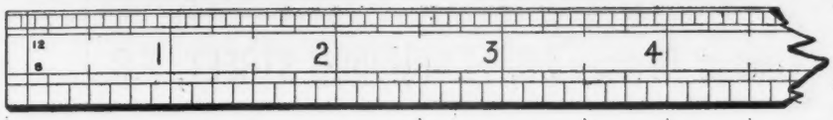

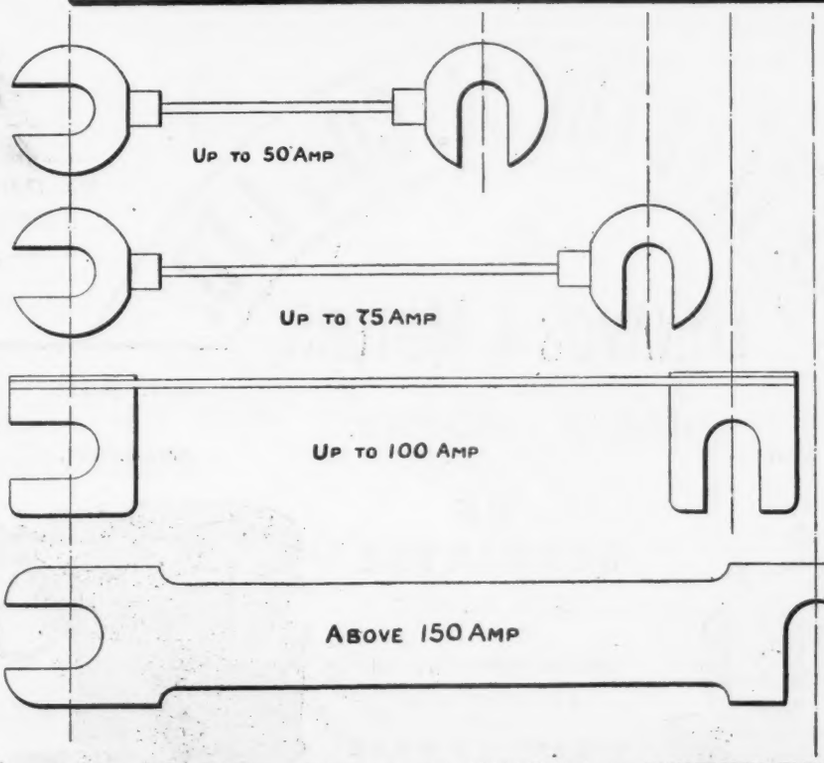

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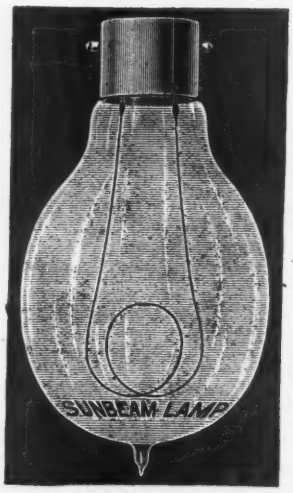

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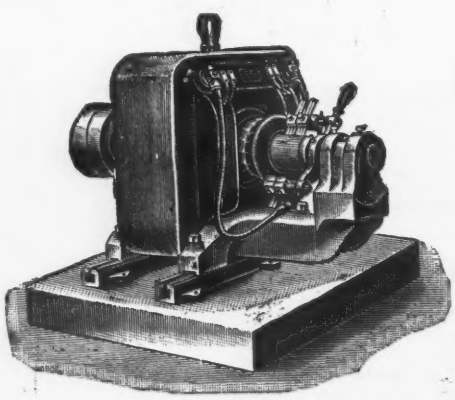

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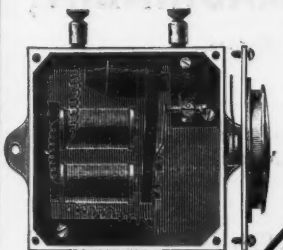

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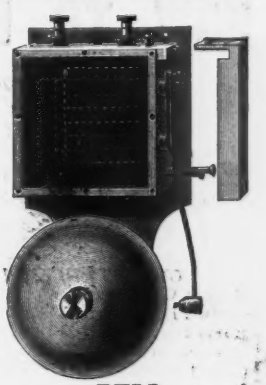

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Official Notices.

MUNICIPALITY OF SHANGHAI.

THE COUNCIL FOR THE FOREIGN COMMUNITY OF SHANGHAI require, if possible by April 1st, 1898, a Chief Municipal Electrical Engineer. Salary, at present rate of exchange, about £460 per annum, with quarters, coal, gas and medical attendance. Age (single man preferred) 28 to 40. Must pass the ordinary insurance medical examination.

The gentleman selected must undertake to devote his whole time to the duties. He will serve under the Works Committee, and must be competent to advise, carry out extensions, and conduct routine correspondence. There is a competent English Assistant. He should have a thorough knowledge of the management of alternating plant and continuous current arc lighting, good knowledge of mechanical engineering, and be able to prepare estimates for independent installations. It is desirable that he should have been in charge of a central station.

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Further particulars may be obtained from Messrs. JOHN POOK & Co., 8, Jeffreys Square, St. Mary Axe, London, to whom all applications for the appointment should be forwarded before JANUARY 15th, 1898. 2005

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Applications by letter, stating age, whether married or single, and giving full particulars of experience, accompanied by copies of testimonials (not originals), with names and addresses of references of whom enquiry can be made as to capabilities and character, will be received by the Crown Agents for the Colonies, Downing Street, London, S.W., up to the 6th January.

The Crown Agents possess no further information in respect of the above appointment, and cannot undertake to answer enquiries.

December 15th, 1897. 2118

Official Notices.—*Continued.*

CITY OF BRADFORD.

TO STEAM ENGINE MAKERS.

THE CORPORATION OF BRADFORD require Tenders for the construction and delivery of Two Steam Engines for their electricity works at Valley Road.

A specification may be had on application to Mr. Alfred H. Gibbings, Electricity Department, Town Hall, Bradford, on payment of One Guinea to the City Collector, Town Hall. This sum will be returned on receipt of *bona fide* tender accompanied by the specification.

Sealed Tenders, endorsed "Tender for Steam Engines," to be sent to the undernamed office on or before THURSDAY, JANUARY 13TH NEXT.

An assurance must be given by each contractor that he will pay to the workmen employed by him not less than the minimum standard rate of wages.

The Corporation do not bind themselves to accept the lowest or any tender.

GEORGE McGUIRE,
Town Clerk.

Town Hall, Bradford,
December 29th, 1897. 2152

Patents, Designs & Trade Marks' Acts, 1883 to 1888

NOTICE IS HEREBY GIVEN that JOSEPH PLATT HALL, of Gorse Bank, Oldham, and WILLIAM HENRY SEVILLE CRAVEN, of Heaton Villa, Cheetham Hill, Manchester, have applied for leave to amend the specification filed in pursuance of the Application for the Letters Patent No. 24,084 of 1896, for "Improvements in or applicable to switches for electro-motors, and the like purposes."

Particulars of the proposed amendments were set forth in the *Illustrated Official Journal (Patents)*, issued on December 22nd, 1897.

Any person or persons may give Notice of Opposition to the Amendment (on form G) at the Patent Office, 25, Southampton Buildings, London, W.C., within one calendar month from the date of the said journal.

(Signed) C. N. DALTON,
Comptroller-General. 2180

[*Continued on next Page*]

Official Notices.—*continued.*

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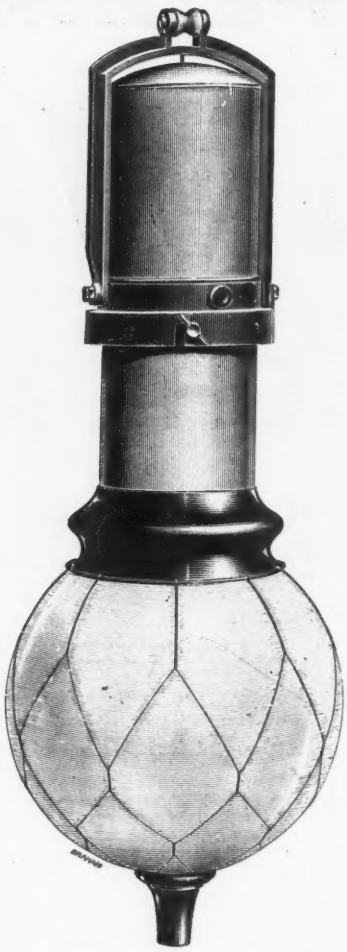

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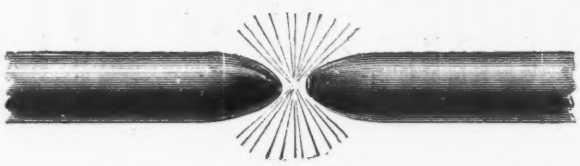

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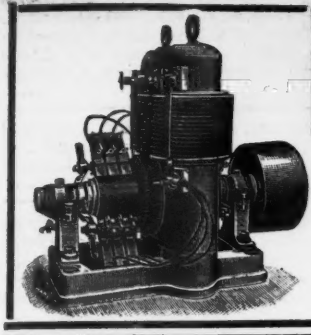

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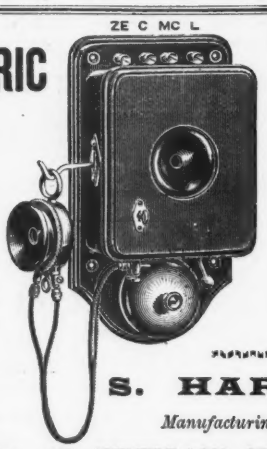

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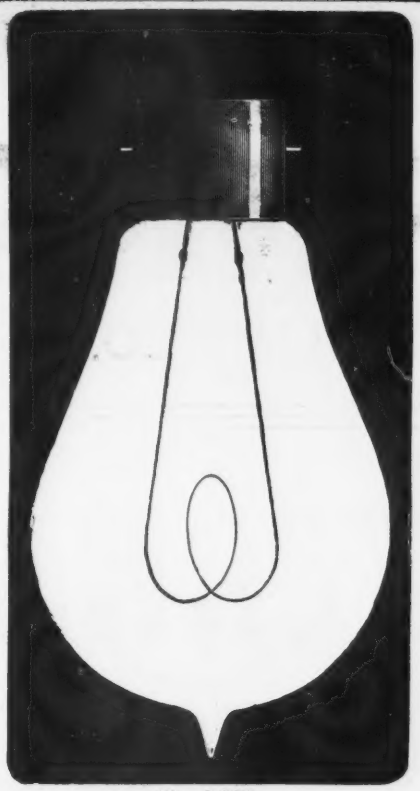

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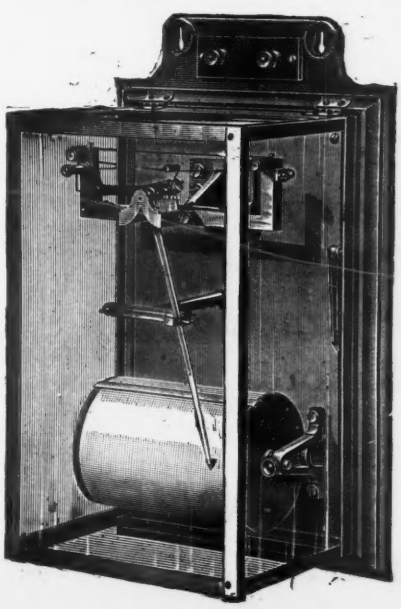

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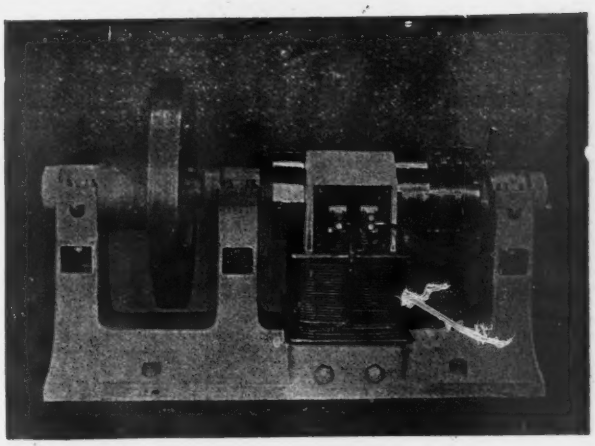

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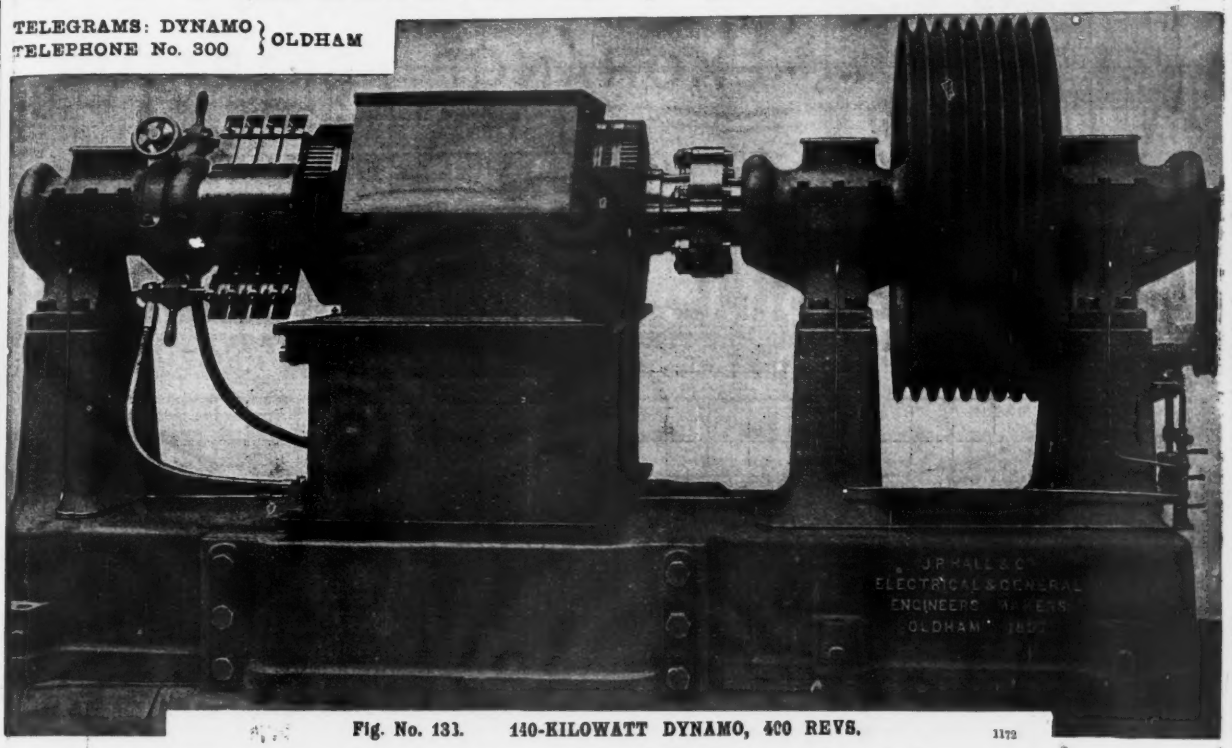

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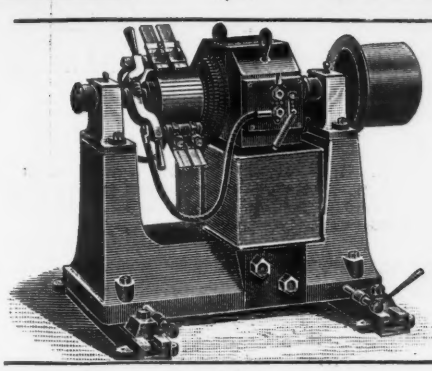

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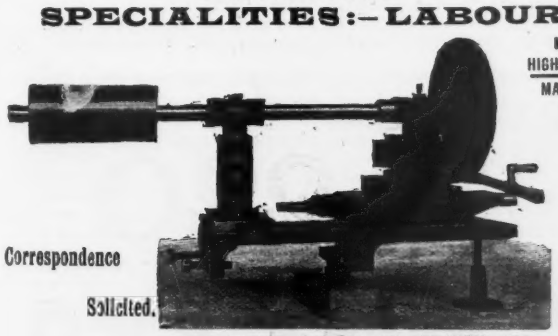

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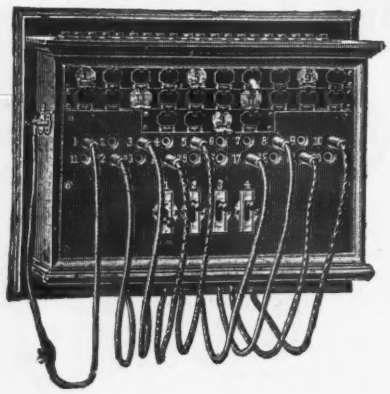

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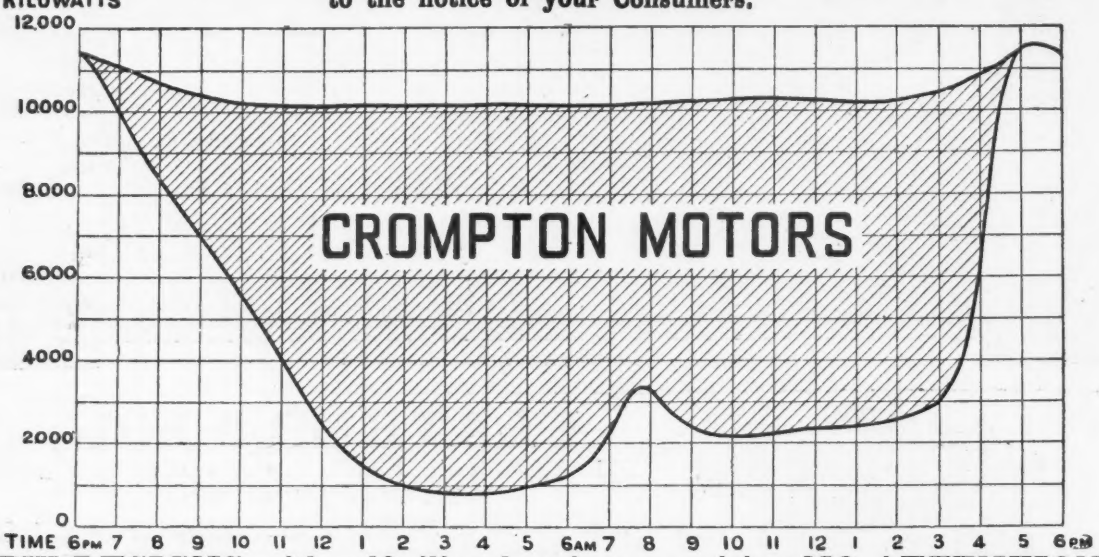

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Perseverance Works, Shrewsbury.—Mr. Thomas Corbett, engineer, iron and brass founder, of the Perseverance Iron Works, Shrewsbury, has adopted a charming method of bringing his manufactures before the notice of the public by adding to his price list a beautifully-illustrated guide to Shrewsbury and its surroundings. This delightful souvenir, which also contains a description of the Perseverance Works, founded about 33 years ago by Mr. Thos. Corbett, J.P., C.C., who is the sole owner, is published by William Macdonald & Co., Limited, of St. Giles Street, Edinburgh, and Leadenhall Street, London, E.C.

The Largest Storage Battery Plant in the World.—The *Electrical Review* of New York says the Electric Storage Battery Company has just closed a contract with the Chicago Edison Company for a storage battery plant, with a capacity of 7,436,800 watt-hours. This will be the largest battery installation ever made. The contract includes switchboard and all auxiliary apparatus, and will be completed in March, 1898. This installation will be an object of great interest to the members of the National Electric Light Association at their next meeting, which is to be held in Chicago in June. The Storage Battery Company has also closed a very important contract with the Buffalo Railway Company. The battery is to be used in conjunction with power furnished by the Cataract Construction Company at Niagara, over their high tension transmission lines to Buffalo. This is a most important development, and one which is being watched with intense interest all over the world. Both of the above batteries are the largest for their purpose that have ever been installed. The year's business done by the Electric Storage Battery Company shows a very remarkable increase over preceding years, and indications are that the coming year's business will far exceed the results of the present year.

The Packing of Export Goods.—*The Review of the River Plate* states that "A few weeks ago we drew attention to the fact that electrical firms in England do not know how to pack, and we were pleased to see that the English technical press took the matter up. We have now another very flagrant case to report. We will, however, withhold the names of the shippers, but if this article should catch their eye we hope that they will see the error of their ways, and when adding large items to their bills for packing, will see that the goods are packed. The case in point is as follows: When at the works of the River Plate Light and Traction Company, an account of which is given in this section, we were very much struck with the marble switchboards that had arrived out of the United States in a perfect condition, without so much as a scratch. The manager informed us that they came splendidly packed, and at the same time stated that two marble switchboards which he had lately received from England for their Rosario and Tucuman stations came smashed to pieces, on account of the atrocious packing. We were shown a sample of American packing in several open cases, and we must confess that it was the best we had ever seen. The manager further told us that English firms have a lot to learn in the packing of arc lamps, as the American houses send them out so that no harm can possibly occur to them during the journey. There is only one point in which English houses beat the American, and that is in the packing of glass. The globes for the lamps that come from the States generally arrive broken, whilst those from England arrive with a smaller percentage of breakage. We hope that if Lord Salisbury's commission come out to these parts they will look thoroughly into this question of packing, as it is a very important one, and if not remedied will be the means of trade going to those countries where packing is given due attention."

ELECTRIC LIGHTING NOTES.

Bo'ness.—The Bo'ness Harbour Commissioners have resolved to proceed with the electric lighting of Bo'ness Harbour and Docks.

Carlisle.—Last week Col. Durnford, inspector of the Local Government Board, held an inquiry at Carlisle, with reference to an application by the Corporation to borrow £30,000 for the purpose of carrying out electric lighting works in Carlisle, and £2,500 for the provision of dwellings for persons who will be displaced from houses by the carrying out of the Bridge Street improvement. Prof. Kennedy (the electric lighting engineer) described the scheme by plans and maps, and stated that the Corporation would themselves put up the arc lamps in the streets, but would not supply the lamps for private consumers. They would only take the mains to the doors of the consumers. In reply to the Inspector, the Town Clerk said a number of people were ready to take the light, and the Corporation would also take the light for their public buildings. The estimated amount to be expended was about £26,300, and that would leave a balance of £3,700 for contingencies, extension of mains, and road work.

Country Mansion Lighting.—Embley Park, Hants, the seat of Major Spencer Chichester, has been fitted with a very complete electric light plant for upwards of 250 lights, in addition to electric pumping arrangements. Duplicate oil engines and dynamos are installed in addition to a 200-light storage battery. The work has been carried out by Messrs. Veritys, to the specification of the consulting engineer, Mr. Morgan Williams.

Electricity in Dockyards.—It is stated that the Admiralty have at last decided, after much vacillation and many changes, to replace the dim and infrequent gas lamps in Portsmouth Dockyard by electricity. It is proposed to build a new shop 150 feet long and 50 feet wide on the space between the present electric station and the wing of the old convict prison, which has recently been converted into an electric store. The Admiralty are now asking for plans showing in what sections it is intended by the dockyard authorities to proceed. When this has been settled the money can be provided, which will amount in round numbers to a total of £100,000, of which propably one-fourth will be required at once. Not only is it intended to substitute the electric light for gas, but also to introduce motors for driving the various smaller machines instead of steam, by which it is believed considerable economy will result. It is likely, therefore, that in the next estimates there will be due provision made for this improvement.

Glasgow.—Prof. Andrew Jamieson writes to the *Glasgow Herald* on the subject of the Corporation electricity supply, and says: "For some time during this winter we have been reduced in the evenings to as low an electrical pressure as 93 volts, whereas during the day-time we get over 103 volts. To-day it has fallen to 78, when the normal voltage should not be under 100. There cannot be any doubt as to the accuracy of our voltmeter, as we have checked it with standard instruments. It is, therefore, high time that the city authorities increased their plant, so that they need no longer attempt to do more than lies within their power and capabilities."

Greenock.—The Greenock Police Board will oppose the application by the North British Electricity Supply Company, Limited, for the supply of electricity in the district.

Ilfracombe.—The District Council have passed a statutory resolution authorising an application for a provisional order.

Italy—The Municipal Authorities of Verona have approved a contract with Messrs. Brown, Boveri & Co., of Baden, Switzerland, for the establishment of an electrical power generating distributing station in the town.

Leeds.—The electric lights which have been fixed on the tramway poles and brackets in Boar Lane and Briggate were turned on last week by way of experiment.

Northwich.—The Northwich Electric Supply Company, Limited, opened the supply of electricity to the town on Friday last. Altogether there has been application for about 700 lights; 450 have now been finished and are connected to the supply. The engine is by Crossley Bros. of Manchester, 100 B.H.P., driving one of Messrs. Laurence, Scott & Co.'s dynamos, giving 125 amperes 480 volts, at 600 revolutions per minute. The supply is 220 volts on the three-wire system with accumulators (by the Chloride Syndicate, Limited) with balancer. The mains are supplied by the British Insulated Wire Company, Limited. Orders have been placed for extension of plant and mains. Mr. T. H. M. Swinburne is the resident engineer.

Norwich.—The extension of the area of the Norwich Electric Lighting Company is being opposed by local District Councils.

Personal.—Mr. F. Kenyon, of the British Insulated Wire Company, Limited, Prescot, has been appointed to the post of assistant engineer to the Northwich Electric Supply Company, Limited.

Rothesay.—The Town Council have resolved to apply for a provisional order.

Salford.—Last week Colonel W. Langston Coke, C.E., an inspector under the Local Government Board, held an inquiry at the Salford Town Hall with reference to an application of the Corporation for power to borrow £13,000 for electric lighting purposes. The Town Clerk explained that £44,770 had already been expended by the Corporation on the electric lighting undertaking, and it was now proposed to construct a battery sub-station under the Regent Road Public Baths. A number of accumulators would be placed in the cellars of the baths and the electrical energy stored there, so as to provide for four hours' consumption of electric lighting at the present rate. The mains would be extended along the Regent Road district, and certain other improvements would be made in connection with the undertaking, so as to meet the public demand, now largely increasing. The Inspector, after examining the plans, &c., said he should report to the Local Government Board in due course

Sheffield.—At a special meeting of the City Council held last week, it was decided to apply for power to issue irredeemable stock wherewith to purchase the undertaking of the Sheffield Electric Light Company. It will be remembered that the Corporation were proposing to exercise the powers reserved to them under the order by which the company was brought into existence for the purchase of the undertaking by the issue of Corporation stock, equivalent to a 5 per cent. annuity on the capital which the company had expended. Under a recent Act the only stock the Corporation have power to issue is redeemable, but the company declining to accept such a stock the matter recently came before Mr. Justice North, who decided that the words "five per cent. annuity" implied irredeemable stock. The Council sanctioned an application for the raising of irredeemable stock. It is understood that the Parliamentary Committee, which has the matter in hand, is approaching the electric light company with a view to amicably settling terms of purchase.

Southampton. — The Electric Lighting Committee reported to the last meeting of the County Council that the output from the electric light works for October was 17,991 units, an increase of 5,043, or 38 per cent. over the number sold in October, 1896. In reply to a letter from the governors of the Royal South Hants Infirmary, the manager of the works had been instructed to state that if the governors would take a sufficient number of lights the committee would undertake to lay the main and the service line to a distance of 20 yards therefrom. Mr. Manville, the consulting engineer, had been requested to report upon the desirability or otherwise of the wiring of premises of consumers by the Corporation on the lines adopted by the Free Wiring Syndicate, and also upon the penny-in-the-slot system. The town clerk had been instructed to report upon the subject of the terms under which the Corporation are supplied with gas for street lighting. Some conversation took place as to the alleged inefficient lighting of an hotel, which led a member to remark that as a consumer he had no fault at all to find with the light, but he expressed his belief that many people used the lamps for more than the regulation 1,000 hours, and the complaints which then arose were simply due to the lamps needing renewal. The committee's report was adopted.

Stepney and Bow Foundation.—The Governors of the above Foundation have instructed Mr. Morgan Williams to report on the question of the electric lighting of the large new high schools which the Foundation have now in course of erection.

Stockport.—A Local Government inquiry was held last week at Stockport Courthouse with reference to the application by the Corporation for permission to borrow £25,000 for laying down the electric light installation in the borough. It is proposed to first light the centre of the town, and extend if desirable to other parts. The proposals are popular in the borough, which has during the last 10 years increased at the rate of 1,000 yearly, the present population being close on 80,000.

Swansea.—The Swansea New Market is now lighted by electricity. The contract for the undertaking was taken less than a fortnight ago, but by Wednesday Mr. John S. Brown had completed his task. The electrical power is supplied by the Swansea United Breweries Company from their establishment close by.

Walsall.—The Grand Theatre has been fitted up for electric lighting.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Folkestone and District Electric Tramway.—A special meeting of the Cheriton Council is to be held to thoroughly go into the matter, and also into that of the Light Railway Company's scheme.

Keynsham.—In connection with the proposed extension of the electric tramway to Brislington, a notice was received by the Keynsham Guardians, the chairman intimating that it did not appear likely that the authorities of the Union would oppose the extension.

L.C.C. Tramway Schemes.—The London County Council have deposited two Bills for next session for powers to construct new tramways. By the first of these Bills it is proposed to construct a double line of tramway, commencing on the south side of Westminster Bridge by junctions with the existing tramways of the London Tramways Company and the South London Tramways Company, and passing from thence over Westminster Bridge and along the whole length of the Victoria Embankment to Blackfriars Bridge. The extension, which is to be completed in two years, is proposed to be worked by the existing tramway companies under agreement with the Council. By the second Bill a tramway is proposed from Holborn Town Hall along Rosebery Avenue to Islington, and from High Street, Shoreditch, along the Bethnal Green Road, both extensions connecting with existing lines. The cost of these extensions is estimated at £86,000.

Light Railways in Argyll.—At Argyll County Council last week, the Committee on Light Railways recommended the Council to inform the Caledonian Company and Callander and Oban Company that they could not promote a railway between Dalmally and Ardrishaig and Campbeltown, but would do all in their power to influence the proprietors to promote the undertaking, and recommend the railway companies to confine their efforts, in the meantime, to promote a railway from Dalmally to Ardrishaig and Crinan, because in this portion of the line they had already a promise of 28 miles of the line out of 40 at a nominal value. The report was adopted.

Liverpool.—At a meeting of the Lighting Committee of the City Council held last week a deputation from the Tramways Committee attended with reference to the lighting with electricity of the experimental line of tramways. It was agreed that the suggestion of having central poles with electric lamps in Prince's Avenue be adopted. The consideration of the question of having side poles was adjourned. Additional electric light mains were ordered to be laid in Byrom Street and Duke Street.

Proposed Electric Railway.—A Bill to incorporate the New Cross and Waterloo Railway Company has been deposited in the Private Bill Office. The proposed company seek power to construct an underground electric railway commencing at a point in Old Kent Road near the bridge carrying the London, Brighton & South Coast Railway over that road, and terminating under Waterloo Road, near the point where the South Eastern Railway crosses that thoroughfare. The capital proposed to be created by the company is given in the Bill at £975,000, which is proposed to be divided into 97,500 shares of £10 each, but with power to subsequently divide these shares into "preferred half-shares," and "deferred half-shares." Upon this capital borrowing powers are proposed to be exercised by the creation of debenture stock to an amount not exceeding £325,000. The first directors of the company, who are also given as the promoters, are Mr. James Heath, M.P., Mr. Robert Arthur Read, and Mr. Thomas S. Sden. The Bill contains provisions prohibiting the construction of ventilators, or other openings, in any road or footway, and also the exhibition of advertisements upon any part of the works. During the period of construction power is sought to pay interest out of capital to an amount not exceeding £80,000, and power is sought to enter into working agreements with the London and South Western Railway, the Waterloo and City Railway, and the Baker Street and Waterloo Railway companies.

Tynemouth.—Ald. Armstrong, in moving the adoption of the Trade and Commerce Committee's report at a recent meeting of the Town Council, said the negotiations between the British Electric Traction Company and the Corporation for the establishment of light railways and an extension of the tramways were making very satisfactory progress, and there was a prospect of an arrangement being arrived at that would protect the interests of the ratepayers and be acceptable to the company.

TELEGRAPH AND TELEPHONE NOTES.

Cable Repairing under Difficulties. — The cable steamer *Britannia*, 858 tons (Captain Woodcock), from London for the North Atlantic, to repair a telegraph cable, put in at Queenstown yesterday afternoon, says the *Daily Telegraph* of 28th inst., through stress of weather. She was about 200 miles west of Scilly, repairing a cable, but had to buoy it and bear up for Queenstown.

Cables in the China Sea.—In connection with the evolution of events in China, a contemporary says: "We are in close telegraphic communication with the most important ports in China, and the Foreign Office is made acquainted with every move that is made." This is satisfactory, as far as it goes, but we have frequently pointed out with what ease, should the occasion unfortunately arise, this means of communication could be interrupted. In the Southern China Sea the water, in which the cables run, for many miles is quite shallow, and it is in that neighbourhood that these cables would probably be cut, and communication with England interrupted. That the cables which run into Singapore, as a centre, from India, China and Australia could be destroyed with the greatest of ease requires no demonstration; as in the Java Sea and the south-west portion of the Chinese Ocean, some 3,500 miles of these cables lie in water less than 50 fathoms in depth, a great portion of it being in water only 20 or 30 fathoms deep, and thus easily dealt with by any vessel carrying only the ordinary allowance of chain cable and anchors. Should these cables be destroyed, we would have to rely on the landlines across Siberia and Russia for a means of communicating with the Fleet in the Far East!

Cables v. Warships.—We learn from a Cape Town telegram that "The leaders of the Afrikander Bond have presented an address to Sir Alfred Milner protesting against a colonial contribution to the navy in any shape or form, but expressing a desire that the colony should contribute £20,000 a year towards an all-British deep sea cable to England." The generosity of this offer, as regards the cable side of the question, might almost excuse the reluctance to support Sir Gordon Sprigg's Jubilee offer of an ironclad to the Imperial Navy, were it not that this generosity is uncalled for. It is very necessary, as has been often proven, that the cable routes to the Cape should be improved; and no one is in a better position to know this than Sir James Sivewright, who, besides being in the Cape cabinet, is one of the leaders of the Afrikander Bond. To lay a new cable from England to Cape Town, along the route indicated by a correspondent of the *Times*, who seemed to speak with some authority, about 6,500 miles of cable would be required; and such a cable, touching at St. Helena and Ascension, among other places, could be laid for about £950,000. Now it will be within the knowledge of Sir James Sivewright, who successfully negotiated the extension of subsidy granted to the Eastern and South African Telegraph Company, that this company at the expiry of its 20 years' agreement on May 9th, 1899, will have received in subsidies from the English, Cape of Good Hope, Natal, and Portuguese Governments, a total sum of £1,200,000 (independent of the £196,000, which it will then have received from the English Government in subsidies for the branch line to Mauritius). During this period the company in question has paid dividends, in some cases of 18 per cent. and 19 per cent., and has doubtless accumulated a very substantial reserve fund. With these figures before us, it seems that it would be altogether out of place to expend another £20,000 a year on a company which, by this time,

should be quite in a position to lay such a cable as that above spoken of out of the amount already received. It is rather to be wondered at, in view of the frequent interruptions which have occurred, that the suggested cable has not already been laid by the company in question.

Telegraph Delays.—The dearth of news from Japan, says the *Daily Mail*, is without doubt due to the monopolising of the lines by the State. The effect of this control of the cables is to delay messages to England until a mail boat reaches Nagasaki, a period of four or five days. The cables at Nagasaki are owned by the Northern Telegraph Company, which is a Russo-Danish undertaking—mainly Russian. We have, therefore, to be thankful for any news at all.

A deputation from the Liverpool Chamber of Commerce has complained to the Postmaster-General of the delays in the transmission of telegrams between Liverpool and the Continent, and asked, among other things, that a telephone service should be established between Liverpool and Havre. The Postmaster-General undertook that a new duplex wire should be made available between Liverpool and Hamburg, and held out a hope that if it were found practicable, telephonic communication would be established between Liverpool and Havre.

Telegraphic Interruptions and Repairs:—

CABLES.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Otranto-Vallona	Oct. 11th, 1897 ...	...
San-Thomé-Loanda	Dec. 13th, 1897 ...	...
Saigon-Thuanan	Dec. 20th, 1897 ...	...
Ceara-Maranham	Dec. 23rd, 1897 ...	...
Teneriffe-St. Louis (Senegal)	Dec. 24th, 1897 ...	...
Grenada-Trinidad	Dec. 29th, 1897. ...	...
LANDLINES.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Communication with Yucatan	Dec. 25th, 1897 ...	...

The Commercial Cable Company.—The Commercial Cable and Telegraph Company has been incorporated at Albany with a capital of $100,000. The general route of the company is from New York City to Mojave, Cal., touching all important cities on the route, and having branches from the main line throughout all States traversed; also through the New England and Southern States and from New York to England and France. The directors include John W. Mackay, Albert B Chandler, Dumont Clark, William C. Baker, Clarence H. Mackay, G. G. Ward, William C. Van Horn and Charles R. Hosmer.

West India Cable Communication.—Once more we have to record the total interruption of communication with Trinidad and British Guiana by the breakdown of the Grenada-Trinidad cable. The St. Croix-Trinidad cable, which is the duplicate route to the above places, has been "on strike" since November 2nd, 1896, and the cable, the interruption of which we now record, already boasts of two interruptions this year, viz., from February 4th to March 9th (33 days), and June 2nd to July 6th (34 days). However, West India merchants may be consoled, for the official notice from Berne states:—"There are frequent opportunities for the transport of telegrams by steamer and sailing vessel." This, as before, means, we presume, 24 hours' delay. A new cable is now being laid from Bermuda to Jamaica, being an extension of the cable of the Halifax and Bermudas Cable Company.

CONTRACTS OPEN.

Bilbao.—February 28th. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Bilbao, reporting that the provisional board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tenders, to be received by February 28th, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tram line and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Bedford.—January 10th, 1898. The Electric Light Committee want tenders for the supply and erection of a 420 B.H.P. double-acting compound enclosed engine, and a 250-unit alternator with stationary armature. See our "Official Notices" December 10th for particulars.

Bootle.—January 10th, 1898. The Corporation wants tenders for the supply and erection of boilers, engines, dynamos, switchboard, pumps, transformers, wiring, alteration of Town Hall wiring, batteries, mains, street boxes, and the running of the electricity works for three years. Consulting engineer, Mr. T. L. Miller, 7, Tower Buildings, Water Street, Liverpool. See our "Official Notices" December 10th for further particulars.

Bradford.—January 13th. The Corporation are asking for tenders for two steam engines for their electricity works at Valley Road. Further details will be obtained from our "Official Notices."

Glasgow.—The Clyde Trust is considering a comprehensive scheme for the lighting of the Quays. For the lighting of the Queen's Dock it is proposed to use between 30 and 40 arc lamps. The lighting of the Cessnock Dock Works area is also being considered.

Gloucester.—January 18th. The Electricity Committee want tenders for boilers, dynamos, overhead crane, switchboard, accumulators, mains, arc lamps, meters, &c., for electric lighting. Consulting engineer, Mr. Robert Hammond. See our "Official Notices" December 10th.

Huddersfield.—January 4th. Tenders are being invited for extending the Corporation electricity supply works. Forms of tender may be obtained from the Borough electrical engineer.

Leicester.—January 31st. The Leicester Corporation invites designs and tender for motor vehicles for the collection of house refuse. Specifications and particulars, with drawings, to be sent to the Chairman of the Sanitary Committee, to the office of Mr. E. Geo. Mawbey, C.E., borough engineer, Town Hall, Leicester.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—January 11th. The Vestry want tenders for wiring materials for one year. Particulars can be seen at the Lighting Engineer's Office, Town Hall.

Southampton.—January 1st. Tenders are being invited from local firms for the electric wiring and fitting of the electricity supply station, Back-of-the-Walls, Southampton. Engineers, Messrs. Kincaid, Waller and Manville.

Spain.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Chargé d'Affaires at Madrid, transmitting copy of a Royal Order inviting tenders for the construction and working of a telephone system in Tarragona. Sealed tenders will be received at the office of the Civil Governor of the province of Tarragona for 40 days, counting from the 11th inst. Further particulars of the conditions of the tenders may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Spain.—January 9th. The municipal authorities of Torrente (Valencia province) are inviting tenders for the concession for the electric lighting of the town during a period of 17 years. Tenders to be sent to El Secretario del Ayuntamiento de Torrente (Valencia).

FORTHCOMING EVENTS.

1898.

Tuesday, January 4th.—The Royal Institution. Fourth of a series of six Christmas lectures (juvenile) on "The Principles of the Electric Telegraph," by Dr. Lodge, F.R.S.

Thursday, January 6th.—The Royal Institution. Fifth of a series of six Christmas lectures (juvenile) on "The Principles of the Electric Telegraph," by Dr. Lodge, F.R.S.

LEGAL.

THOMAS PARKER, LIMITED.

Union and Non-union Men at Loggerheads.

ON Wednesday, at the Wolverhampton Police Court, before Mr. N. C. A. Neville, stipendiary magistrate, Thomas Parker, Limited, electrical engineers of Wednesfield Road, Wolverhampton, were summoned by two of their former employés, Frederick Bailey, mica gauger, and Thomas Godwin, commutator builder, each of whom claimed £2 12s. in lieu of wages. The workmen were represented by Mr. A. Turtin, solicitor; while Mr. J. G. Underhill appeared on behalf of the company.

Mr. TURTIN said Bailey had been employed by the company for two years and nine months, and Godwin for two years and three months. In the brass department there was a notice posted to the effect that workmen who had been employed by the company for 26 weeks were entitled to either give or take seven days' notice, and that those who had been employed for 52 weeks were entitled to give or take 14 days' notice. The two men were discharged on November 17th without any wages in lieu of notice. Each was in receipt of

26s. per week, and therefore each claimed £2 12s. for the 14 days' wages.

Bailey, in giving evidence, said he was a union man. In reply to Mr. Underhill, he said that he did not know he had been discharged for interfering with other workmen. When he asked why he had been discharged, he was told that it was for intimidation; but he did not know what that meant, as he had not intimidated anyone. He admitted that he had played cards in the works on two occasions when he ought to have been at work, as he was paid for day work.

Mr. Underhill said that the company found that Bailey and Godwin were interfering with other workmen, and trying to limit the work turned out in the workshop. The company thought that it was dangerous to allow Bailey and Godwin to remain in the workshop, and there was ample justification for the men being discharged.

Alfred Boden, a non-society man, stated that Bailey had spoken to him continually about doing too much work.

Other witnesses were called, who alleged that Bailey and Godwin both complained to them about working too hard. Bailey was credited with the remark about an employé, "Wait till our society is strong enough, and we'll have the——out."

The Stipendiary said there was no doubt that any person working for an employer who did any act, which it had been suggested Bailey did, in trying to prevent other workmen from doing what they considered was their fair share of work, was acting in direct contravention of all the interests of his master, and he was immediately liable to be dismissed for such conduct. The allegation against Bailey had been clearly proved, and he (the Stipendiary) considered the defendants were justified in dismissing him at a moment's notice. In his case there would be a verdict for the defendant. In Godwin's case the facts had not been proved so strongly as he thought was necessary to be shown in order to deprive him of his fortnight's wages. There would, therefore, be a verdict in his favour for the amount claimed.

NOTES.

For 1898.—Following our Christmas greeting of last week, we cordially wish our subscribers, advertisers, contributors, and friends a Happy and Prosperous New Year.

Electricity in Bulk.—The *Times* states that a Bill has been lodged for next Session of Parliament, the preamble of which sets out that great difficulty is experienced by electric lighting companies and local authorities who supply electricity, in providing sufficient electrical energy to enable them to meet the demands of consumers at certain times of the day, whilst the production by each separate company and local authority of sufficient energy to meet the *maximum* demands involves the expenditure of large sums of practically unproductive capital, and results in the consequent enhancement of the price that has to be paid for the electric light. To surmount these difficulties the Bill proposes to confer on one company power to erect generating stations on one central spot in Marylebone, on the banks of the Regent's Canal, and from this point to supply electrical energy in bulk to any "company, body, or person," at such price and on such terms as may be agreed.

A New Mercury Pump.—A new pump, having movable joints, but no taps, is described by H. Henriet in the *Comptes Rendus*, 1897, Vol. 125, pages 22-23. In this pump, the lower extremity of the working bulb is connected by a descending tube, partly of glass, partly of rubber, to a mercury reservoir, which latter can be raised or lowered by a chain and pulley in the usual way. The tube just below the working bulb is branched. The branch ascends vertically for some distance, is bulbed at the top, then again descends, and is finally bent slightly upwards, terminating in a horizontal position, to which the vessel to be exhausted is attached. At the lower bend, connection is made with a doubly-branched tube, both limbs of which descend and terminate in a trough of mercury. One of these limbs is graduated, and serves as a pressure gauge, as also for the introduction of gas into the pump and attached vessels. By means of the second, which terminates in a length of rubber tube, connection may be made with an auxiliary water pump. Returning to the working bulb—its upper portion is drawn out to a capillary tube, which is bent downwards, and terminating in a mercury trough forms the outlet of the pump. In operation, the mercury flowing out of the working bulb presently uncovers the branch tube leading to the exhaust; subsequently, when the mercury is caused to re-ascend, the gas that has passed into this bulb is expelled through the upper capillary tube.

Braincraft v. Handicraft.—One of the most sensible letters on the disastrous strike of the engineers we have yet seen is that of the Duke of Argyll, who has sent the following reply to a correspondent :—

Dear Sir,—I lament with you this disastrous strike of engineers. You ask me if I have no suggestion to make as to preventing such suicidal contests. I have only one suggestion—more knowledge of the natural laws which determine "value" in all things, "labour" not excepted. As far as I can see, the demand made by the employers as to the exclusive control of the management of their enterprises is an absolutely just demand and necessary; and if the refusal of the employed does really turn on this, they are fighting against nature and against justice. Braincraft is the governing power in all industrial enterprises, and all attempts to make it subject to handicraft, which falsely monopolises the title of labour, must end in discomfiture and in disaster to all concerned. If this law cuts at the root of Trades Unionism, as the leaders allege, so much the worse for Trades Unionism, because it is a natural law, which any man can see who exercises his reason dispassionately. But Trades Unionism can do, and has done, much when properly directed, without entering on the unnatural crusade into which it has been seduced by misleading leaders.—Yours, &c., Argyll.

The Measurement of Great Electrical Resistances with a Constant Current.—Some time ago Wilderman, in a research upon the availability of Kohlrausch's method of determining the electrical conductivity of feebly dissociated compounds, declared that this method was unsuitable for slightly dissociated compounds, and almost useless for organic bases or acids in alcohol or any other organic solvent; whilst even when applicable to such cases, it is exceedingly troublesome and tedious. He proposed a method of his own, which he worked out by means of some experiments on the conductivity of the di- and tri-chloracetic acids in absolute alcohol. This method, however, is open to several practical objections, notably, the difficulty of obtaining a sufficiently high and constant electromotive force. In a recent issue of the *Zeitschrift für Physikalische Chemie*, 1897, Vol. 22, pages 331—335, R. Malmström gives an account of some experiments which he has been making with regard to the accurate measurement of great electrical resistances with a constant current. He considers that Wilderman's method must be abandoned, and in searching for a better one, he examined one that was suggested by Nernst a little while ago, and found that for resistances of 1,000 ohms and upwards it is both accurate and convenient, and preferable to either the ordinary Kohlrausch method or to that adopted by Wilderman. Nernst's method is as follows:—In the arms, A B, A C, of a Wheatstone bridge, two adjustable electrolytic resistances are placed; the two arms, B C, C D, contain two similar condensers consisting of two metal plates separated by a movable glass plate. The ends, A D, are connected with an induction coil, and B C to a telephone in which silence, or at least a minimum of sound, occurs when $B_{ab} : B_{ac} = C_{db} : C_{dc}$. A condenser consisting of a nickel or platinum trough with a fixed metal plate in the interior, can be placed in either arm, D B or D C, and its capacity added to either of the measuring condensers, and this contains the liquid whose dielectric constant is to be measured. Minimum sound is then obtained by moving the glass of the measuring condenser. The arms, D B, D C, contain also auxiliary resistances, so that if the compound examined is not a perfect insulator, its resistance can be also determined, since a minimum also results when $B_{ab} : B_{ac} = B_{db} : B_{dc}$. The condensers and other parts of the apparatus are calibrated once for all, and full details of the precautions, and a discussion of the probable errors, are given in the paper. The availability of the method is well seen by comparing the numbers which Nernst obtained with it, and the determinations made by Landolt and Jahn. In the case of 13 hydro-carbons, the mean difference is about 2 per cent., the results by this method being in almost all cases the higher. A number of measurements of the capacity of benzene, aniline, amylic alcohol, ethylic alcohol, and water at varying temperatures, are also recorded; from the results the temperature coefficients are calculated, the dielectric capacity in each case decreasing with increasing temperature.

Death of Mr. James Platt, Gloucester.—We regret to record the death of Mr. James Platt, which occurred at his residence, Somerset House, Gloucester, on Wednesday. Mr. Platt, who was 64 years of age, was senior partner in the well-known engineering firm of Fielding & Platt, Limited, High Orchard, Gloucester.

Lessons from Germany.—Under the head of "Another Lesson from Germany," *Engineering* calls attention once more to the Association for the Promotion of Foreign Commercial Relations, an association which had its origin after the Franco-German war, when peace seemed to be more assured in the future than it does to-day. Stettin was the place of origin, a few Stettin merchants meeting to consider the best means of extending and improving the trade of Stettin, by bringing it more into competition with Hamburg and Bremen, and introducing trans-Atlantic business relations. The means taken were the education of clerks and young men by means of evening classes, for geography, science and languages, especially English, Spanish and French; the sending of young men abroad to work in the interests of the Stettin trade. A stipend was given of £75 for travelling and three months' living, and it was looked upon as a matter of honour to refund this sum when circumstances permitted it, and very few have failed to repay. South America was the country to which most of them at one time preferred to go; but latterly Australia and Africa have been more selected. With introductions to Consuls, and every aid that could be afforded, is it surprising that German trade has been so well developed? To us it seems to be a far better plan than sending one's only brother to preach the Gospel in the name of "Me and the Almighty," and less time seems to have been filled up in kissing good-bye to sisters, cousins and aunts. The emissaries were expected to make reports to the Direction on such points as particular trade legislation, prices of merchandise imported and exported. It appears there is a United States National Association of Manufacturers, formed to collect information; but in England we have nothing but the Consular and Foreign Office reports, better, it may be, than they once were, but still leaving much to be desired, and there is always room for voluntary effort. Consul Powell, whose report to the Foreign Office is the source of the Stettin information, believes the Institution at Stettin to be most valuable, and our contemporary commends the subject to the London Chamber of Commerce as being a suitable and proper one for that body in which to interest itself, this chamber having already instituted an excellent system of examinations in commerce, which it is endeavouring to extend throughout the country.

Maxim's Thick Filament Incandescent Lamp.—This is the title of an article in the *Electrical Engineer*, New York, for December 9th. The actual amount of information propounded is extremely meagre, and amounts to this:—That some months ago an announcement had been made that Mr. Hiram S. Maxim had invented a new incandescent lamp, but that no details had been published. Mr. Maxim has now made a further brief communication regarding his lamp, which is stated to contain a high resistance conductor, or filament, of short and thick form, composed of carbon and other materials. As to the nature of the materials associated with the carbon, or what methods of construction are employed, no hint is given. Neither is any allusion made upon the important questions of efficiency, duration, and cost of the new conductor. So we are almost as much in the dark respecting this new lamp as hitherto. The effect of all ordinary impurities in filaments is well known to be injurious, and the aim of lamp makers has always been in the direction of increasing the purity of the carbon; but it would be rash to assert that a high resistance conductor made on these lines is an impossibility. It is to be hoped that Mr. Maxim has really hit upon a practicable method of constructing such a conductor, and that in due course we shall hear more about it. That it would be extremely valuable, in view of the rapidly-increasing demand for high resistance lamps, goes without saying. We conclude our remarks with the following extract taken from the article referred to:—

> We believe we are violating no confidence when we state that Mr. Edison—who, as every one knows, is an indefatigable experimenter, and who believes in trying everything—in his efforts to find a fluorescent substance for his fluorescent screen work, has made experiments, extending over nearly two years, in which he has made mixtures of pretty well every substance known to science, in almost every possible proportion, with the aim of producing a better filament than the straight carbon filament. He has failed so far to find such a substance. This, of course, does not prove the impossibility of finding one, but it will, nevertheless, serve as an index of the work which has been done on the subject by one whose inventive resources are practically unlimited.

Lighting in Glasgow.—Speaking of the recent foggy weather, of which Glasgow seems to have had its fair share, the *Glasgow Herald* says:—"Apart from its other drawbacks, the dense fog which hung over the city for the past few days involved a considerable outlay in the matter of lighting the streets. On Thursday over 30 millions of cubic feet of gas were used, the same amount as on the previous day. So the fog has meant that for two days over 60 millions of cubic feet of gas have had to be supplied for the lighting of the city. At the electric power station in Waterloo Street business has been very brisk, and Mr. Arnot and his assistants have been pretty hard put to it to meet the exceptional demands caused by the fog. The electrical resources of Glasgow are not yet adequate for the wants of the city. Still, with the means they have, the authorities at Waterloo Street have done well. On Tuesday the electric lighting left a deal to be desired, but on Wednesday and Thursday matters were considerably improved. There were 20,499 units supplied on Wednesday, and something like a similar number on Thursday." The Scottish newspaper concludes its interesting information with the following sentence, which we do not quite know how to take:—"The lighting on Thursday was clearer and steadier, owing to steam coal having been used."

The Alternating Current Enclosed Arc.—The high efficiency of alternating current enclosed arc lamps as compared with similar lamps operating on direct current makes the problem of their proper design one of great importance. As has been pointed out in these columns, says the *Electrical World*, the enclosed lamp is meeting with increasing favour for both street lighting and interior illumination, on account of its many points of superiority and excellence; but, so far at least, the direct current types have been much more successful than those designed to operate on constant potential alternating circuits. The great desirability of good lamps for alternating current is not alone due to the existence of many alternating current installations in which they can be used, but as well to the higher efficiency which should result from the substitution of a reactive coil for the necessary resistance used in connection with the direct current types. The main difficulties which have beset designers of this class of arc lamps have been the humming noise emitted by the alternating arc, and the sensitiveness of the arc itself to small changes in the voltage across it. The paper in another page describing some experiments with a lamp of this type (reproduced in this issue of the REVIEW) shows plainly how large a variation of light is caused by a small variation of voltage, and what close regulation of the supply current is required for good service. Another difficulty with these lamps is their low power factor, causing a considerable flow of wattless current in transformers, lines, and dynamos. This, however, is of minor importance when the high efficiency of the lamps and generators is considered. There is, perhaps, no greater desideratum in central station machinery than large arc generators for direct coupling to engines of reasonable size. The multi-circuit constant current machines have proven very successful, but their size is limited to 200 or 300 light units, on account of the enormous potentials existing in their armatures. The direct current generator, feeding a three-wire system at 250 volts or thereabouts, requires a very costly line. The alternating current generator, however, working at several thousand volts, and feeding districts of arc lamps through voltage transformers, presents a simple and efficient solution of the difficulty, if proper lamps for use with it can be had. To use the direct current type of enclosed arc lamp on an extended distribution would involve the addition to such a system of rotary converters, with the necessity of attendance and sub-station buildings. From all these considerations it is seen that the alternating current enclosed arc lamp has a most excellent opportunity ready made and awaiting its perfection.

Personal.—We are informed that Mr. F. W. Le Tall, Assoc.Inst.E.E., and sometime Mitchell Scholar in the Electrical Department of the City and Guilds Institute Technical College, Finsbury, and Central Technical College, Exhibition Road, Kensington, has passed the final qualifying examination for patent agents. Mr. Le Tall is on the staff of Messrs. W. P. Thompson & Co., who supply the patent information in this Journal.

The Theory of Accumulators.—The source of the electromotive force of a secondary battery is to be found, according to Le Blanc, in the change of quadrivalent into bivalent lead ions; whereas, Liebenoff and Löb assume the presence of the ion $\overline{\overline{PbO_3}}$ in the solution, which, on abandoning its charge, is deposited as lead peroxide. The subject has recently been studied by Karl Elbs, who states in a paper that may be found in the *Zeitschrift für Elektrochemie*, Vol. iii., p. 70, that he is led by his observations on the electrolysis of solutions of the acetates to support the first view. The acetates are divided into three groups: (1) Those yielding at the anode mainly ethane and carbonic anhydride; (2) those yielding mainly oxygen; (3) those from which no gas is evolved. Group (1) includes the acetates of metals of constant valency; group (2) contains the acetates of metals which are bi- or trivalent, and whose higher oxide yields less stable salts than the lower; group (3) contains metals of valency between two and four which form comparatively stable peroxides. In the last two groups it is supposed that the $CH_3 CO_2$ group liberated at the anode combines with the salt in the solution to form the acetate of the higher oxide. These salts are readily decomposed in water; cobalt triacetate, for example, would give cobalt acetate, acetic acid, and oxygen, whilst lead tetracetate yields acetic acid and lead peroxide. From this point of view, the formation of lead peroxide in an accumulator is preceded by the formation of the salt, $Pb(SO_4)_2$, containing quadrivalent lead. Now, according to the views put forward by Elbs, equivalent quantities of lead and lead peroxide should separate at the electrodes when a solution of lead acetate is electrolysed. Löb's experiments show that this is not in general the case; by using a large anode, the greater part of the lead may be deposited as peroxide. To explain this anomaly, Elbs supposes that lead tetracetate diffuses from the anode to the cathode, and there dissolves the lead. Löb rejects this explanation, because if lead tetracetate were distributed through the whole solution, lead peroxide should not separate only at the anode. Even if lead tetracetate acted in the way supposed by Elbs, equivalent quantities of lead and lead peroxide would be found, only they would not be equivalent to the quantity of electricity passed through the cell. Löb thinks that the phenomena are most readily explained by supposing that the solution contains the ion $\overline{PbO_2}$, which need be present only in very small quantity, and which may be produced by the hydrolytic decomposition of the lead salt. Löb's paper may be found in the *Zeitschrift für Elektrochemie*, Vol. iii., p. 100.

Production of Alkali Percarbonates by Electrolysis.—At Zurich a method is being worked for manufacturing alkali percarbonates by electrolysis. It consists in electrolysing a saturated solution of a carbonate of an alkali metal or of ammonium at a temperature below 0° C. If a saturated solution, say of potash, made at — 10° C., and cooled down to — 16° C., be electrolysed, with or without a diaphragm, a bluish salt is obtained, which is found to consist of percarbonate of potassium mixed with more or less potassium carbonate of potash, and to possess oxidising properties. The current strength employed may vary between 1 to 300 amperes per square decimetre of anode surface.

Thermal Amperemeter.—At a recent meeting of the Paris Academy of Science, C. Camichel described a new thermal amperemeter. The apparatus comprises a delicate thermometer, the bulb of which is surrounded by a slightly wider tube of glass, the annular space between the two being filled with mercury, and the whole suitably screened from air-currents. The current to be measured is passed through the mercury jacket for 30 seconds, and the elevation of temperature noted. The apparatus is calibrated by comparison with a standard amperemeter. Its scale is open and regular and, according to the author, the increase of temperature corresponding to a given current remains constant when the initial temperature ranges from 15 to 28° C. The instrument is not liable to get out of order, and is especially suitable for checking the indications of the amperemeters in distributing stations. In a voltmeter, constructed on the same principle, the dilatation of a column of mercury of high resistance is measured.

The Cadmium Standard Cell.—In the *Annalen der Physik und Chemie*, Vol. 59, page 575, R. Wachsmuth and W. Jaeger recommend a cell similar to the H-form of Latimer-Clark cell with platinum electrodes sealed into the glass. In one limb is placed cadmium amalgam (1 of Cd to 6 of Hg), covered with crystals of cadmium sulphate, and in the other pure mercury beneath a layer of mercurous sulphate, the tube being filled with saturated solution of cadmium sulphate, and sealed with paraffin and cork, with shellac over all. The electromotive force of the cell at 20° C. is 1·019 volt, and its temperature coefficient is about $\frac{1}{20}$th of that of the Latimer-Clark cell. The following formula is given:—

$$E\,t = E_{20} - 38 \times 10^{-5} \times (t - 20) - 0{\cdot}065 \times 10^{-5} \times (t - 20)^2,$$

where $E_{20} = 1{\cdot}019$ volt. This formula holds good between 5° C. and 25° C., but between 0° and 5° C., some cells were found to have an electromotive force after being higher than the calculated value. The cadmium cell quickly recovers its normal electromotive force after being heated or cooled through 16° or 17°. The addition of 2 per cent. of zinc to the cadmium amalgam only raised the electromotive force about 39×10^{-5} volt. An amalgam containing 1 per cent. more cadmium than usual had an electromotive force about 0·001 volt too high. To ensure absence of free acid, the cadmium sulphate should be digested with cadmium hydroxide, filtered, warmed with mercurous sulphate, and again filtered, and the mercurous sulphate should be washed with distilled water till it begins to turn yellow from the formation of basic sulphate. The maximum variation from the normal electromotive force of a number of cells which have been under observation since July, 1894, was 8×10^{-5} volt.

The Chemical Action of Electrical Oscillations.—Researches in that mysterious borderland where the chemical verges upon the physical, and *vice versâ*, are amongst the most fascinating to which the scientist can direct his attention, and we have always felt that the great discoveries of the immediate future will be made by those who bring their minds to bear upon those obscure problems which beset the investigator directly he begins to venture into this great unknown. Amongst them is the chemical action which electrical oscillations are able to exercise under suitable conditions, and a good deal of work has been done by Alexander de Hemptinne. Amongst his most recent work, we may notice his investigation on the effect of the wave-length of the oscillations. In order to determine this, he has estimated the maximum pressure at which the tube became luminous when subjected to the influence of the oscillation, investigating the cases of tubes with allylic alcohol, acetone, propylic aldehyde, methylic alcohol, and ethylic alcohol. Of these, the two last showed a marked increase of sensitiveness as the wave-length increased, but, in the other cases, the pressure remained almost constant except for acetone, where a maximum of sensitiveness was obtained in the middle of the series. De Hemptinne describes an experiment, illustrating the metallic conductivity of a glowing tube, and points out that, from the analogy to metals, the chemical action would be expected to vary with the wave-length. According to Ebert, the spectra of vapours vary with the wave-length; but, although De Hemptinne also finds a slight variation in the compounds examined, he points out that this may be due to decomposition and the formation of new products; the influence on the spectrum of the substance itself, therefore, is doubtful. In general, the sensitiveness increases with the molecular weight, but it is dependent, also, on other data, thus ethylic ether is less sensitive than acetone. The temperature has also a very marked effect, but its complete investigation was postponed for a time; a magnetic field appeared to have no influence.

The Electrolysis of Sodium and Potassium Chloride Solutions.—In a review of recent progress in inorganic electro-chemistry, C. Cheneveau (*vide* the *Revue de Physique et de Chimie*) discusses the electrolysis of these solutions. Minet states that asbestos diaphragms give the best results. As anodes, Peyrusson's silver-coated with platinum or iridium, Hoepfner's ferro-silicon and graphitoidal carbon, obtained by the methods of Castner and others, are mentioned.

The Electrolysis of Mixtures.—When a mixture of aqueous solutions of copper sulphate and of sulphuric acid is electrolysed, hydrogen and copper are, as a general rule, set free at the cathode, but sometimes copper alone. According to Hittorf's views as to the nature of electrolytic processes, the current traverses the two dissolved electrolytes in proportion to their respective conducting powers in the mixture. Primarily, hydrogen and copper are set free at the cathode; but by a secondary reaction, a portion of the primary hydrogen may deposit more copper. The author has endeavoured to determine this portion under various conditions. The investigation naturally would fall under two heads:—(A) The determination of the ratio, x, in which the current divides between the two electrolytes. Upon this can be based (B) the actual experiments upon the question above stated. (A) has an interest apart from (B), and from the purely theoretical point of view, is perhaps the more important question. The most important experimental results are the following:—(1) By translation experiments the author has succeeded in determining the ratio in which the current divides between the components of two mixtures, viz., (*a*) aqueous solutions of potassium chloride and potassium iodide; (*b*) aqueous solutions of sulphuric acid and copper sulphate. The results thus obtained are used to calculate the change of the degree of dissociation of the components produced by mixing. (2) The translation number of acetic acid approximates with increasing dilution to the theoretical value, $N = 0{\cdot}119$; but even with a dilution of $V = 4$, this value is not quite attained. (V is the number of litres which contain a gramme-molecule of CH_3, COOH. The translation numbers are those of the anions of the components in accordance with Hittorf's definition; so that if these be N and N_2, the translation numbers of the cations are $1 - N_1$ and $1 - N_2$). (3) From the results of (1) the author determines what fraction of the primary hydrogen goes to deposit copper (in the case of mixed solutions, $CuSO_4$ and $H_2 SO_4$). Within the limits of experimental error the fraction, σ, can be expressed by the formula

$$\sigma = \frac{A}{C + B}$$

when C is the current density, and A and B are constants. For sufficiently dilute solutions, B appears to be equal to A so that the formula takes the simpler form—

$$\sigma = \frac{A}{C + A}.$$

The above is an abstract of a paper by A. Schrader, in the *Zeitschrift für Elektrochemie*, 1897, No. 3, pages 498—505.

A Simple Cause of Breakdown.—The breakdown at the Sardinia station on Friday evening, 17th inst., is described by an esteemed contemporary as having arisen from a very simple cause. It appears that one of the cable ends behind the switchboard dropped from the thimble connecting it to the board, the cable probably having been imperfectly "sweated" into the socket. An arc was instantly formed, and, before it could be extinguished by throwing sand upon it, set fire to five rubber-covered cables, which served as feeders for a portion of the area supplied from this station. This looks suspiciously as if the five rubber cables were bunched, but as the engineer to the Metropolitan Company recently stated in a Court of Law that the bunching of wires is quite harmless, we must dismiss such a supposition from our minds as purely imaginary.

English Steel Rails at 125 dols.—In tearing up a siding, says the New York *Electrical Engineer*, on the Straitsville division of the Baltimore and Ohio Railroad the other day, the section men discovered that several of the rails had been made in 1863. Subsequent investigation revealed the fact that these rails were part of a lot that were bought in England during the war at a cost of $125 per ton in gold. The rails were still in very fair condition, and for light motive power would last 10 years longer.

Our Central Station List.—We would call attention to the fact that the Central Station List which forms the supplement to this issue can be obtained mounted on canvas, price 1s., or post free, 1s. 6d.

The Heilmann Locomotive.—The Heilmann locomotive, in its latest form, has been constructed, and began to take its trial trips on the lines of the Compagnie de l'Ouest on November 12th. These trials we have already briefly referred to in the Electrical Review. The locomotive is to draw successively trains of 200, 250 and 300 tons at respective speeds of 30, 50, 60 and 100 kilometres per hour. Not until the results of all these trials are stated conclusively will it be possible to form a definite opinion on the advantages and disadvantages of the Hielmann electric locomotive. In the meantime, we may give a general description of the locomotive. The locomotive, properly so called, is 18 metres long. The boiler, constructed after the ordinary locomotive type, with a Belpaire firebox of copper, is placed behind, and is capable of furnishing 13,500 kilogrammes of steam per hour at a pressure of 14 kilogrammes per square centimetre. On each side of the boiler are reservoirs holding 7 tons of water. In the middle of the fore part of the locomotive is placed the Willans compound engine of 1,500 H.P. The principle motive axle bears at each extremity a toothed armature of a Brown electric machine, with six poles, of 450 kilowatts at 500 volts, and at 400 revolutions a minute. The power of the two electric machines is therefore 1,200 H.P. The excitation of the two dynamos is independent, and is supplied by a special little Brown dynamo with four poles, giving 110 volts and 140 amperes at 550 turns a minute. This dynamo is started by a little independent Willans vertical engine. The two generating dynamos generally work in parallel. The current produced is conveyed to a distribution board, from which eight circuits branch out, each feeding a motive axle. These axles are placed four in front and four behind, with a space between of 5·50 metres. The total weight of the locomotive alone is 124 tons, but when in service it has to be accompanied by a special truck containing a reservoir of water weighing 20 tons. We must, therefore, estimate the total weight of the Heilmann locomotive at 169 tons. The first experiment, made on November 12th, consisted in drawing a train of 150 tons at 30 kilometres an hour, cannot furnish us with any useful information.

What is it all About?—Mr. Henry Edmunds sends us the following letter, but on the face of it it is not clear to what it refers. For instance, we, although members of the Institution, know nothing respecting either the autographs or album mentioned:—

> It will probably interest many of your readers to know that a private and confidential communication which has been sent to all the members and associates, home and foreign, of the Institution of Electrical Engineers, has been very liberally responded to, so far as replies have been received. I shall, however, be glad through the medium of your journal, to ask any members or associates who have not yet replied, to be good enough to do so at their earliest convenience; and in any event to favour me with their autographs for the proposed album, if they have not already done so. For obvious reasons, you will understand why I do not give details as to names in connection with this matter; but, on behalf of the executive committee, of which I have the honour to be secretary,
>
> I remain, yours faithfully,
>
> Henry Edmunds.

The Engineer for Glasgow.—The Glasgow Corporation on Wednesday appointed Mr. W. A. Chamen, of Messrs. Crompton & Co., London, to be electrical engineer for the City of Glasgow. Congratulations.

NEW COMPANIES REGISTERED.

New Zealand Light and Traction Company, Limited (55,335).—Registered December 20th, with capital £5,000 in £100 shares, to acquire any concessions and rights relating to the supply of electricity in New Zealand, and to carry on the business of electricians, electrical and water and gas engineers, suppliers of electricity, electrical apparatus manufacturers, &c. The subscribers are: J. A. Kelman, 51, Highbury New Park, N., secretary, 3 shares; J. Rowell, Beddington Park Villa, Hackbridge, merchant, 2 shares; William Lewis, 95, Southgate Road, N., accountant, 1 share; S. C. Brady, 135, Lordship Road, N., 1 share; D. Slutor, 22, Dorothy Road, Lavender Hill, S.W., clerk, 1 share; H. R. Savory, 18, Glenelden Road, Streatham, gentleman, 1 share; W. W. Paine, 14, St. Helens Place, E.C., solicitor, 1 share. The number of directors is not to be less than 3 nor more than 5, the subscribers are to appoint the first. Qualification, 1 share. Registered by Paine's & Co., 14, St. Helens Place, E.C.

European Electric Finance Company, Limited (55,375).—Registered December 22nd, with capital £5,000 in £1 shares (2,000 deferred), to adopt an agreement with H. Landsberg, and to acquire, construct, equip, maintain, and work any electric lighting and power works, railways, tramways, water-works, telegraph lines, and canals, &c. The subscribers (with one share each) are:—F. L. Burnside, 7, Eastcheap, E.C., accountant; F. Wyatt, 16, Allington Road, Tulse Hill, clerk; W. N. Morrison, 16A, Tokenhouse Yard, E.C., gentleman; A. Powles, 22, Albert Road, South Norwood, secretary; S. G. Benge, 76, Bromfelde Road, Clapham, clerk; C. J. Kneller, 10, Draper's Gardens, E.C., clerk; A. S. Jacques, 10, Draper's Gardens, E.C., clerk. Registered without Articles of Association by Mayo & Co., 10, Draper's Gardens, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Anderson Electrical Traction Syndicate, Limited (52,926).—This company's statutory return was filed on November 9th. The capital is £500 in £1 shares, and 4,020 have been taken up. 2,010 are considered as paid, and £2,010 has been received.

Central Electric Supply Company, Limited (53,080)—This company's statutory return was filed on October 26th, when seven shares were taken up out of a capital of £200,000 in £5 shares. No calls have been made.

East Grinstead Electric Lighting Company, Limited (48,522).—This company's annual return was filed on November 5th, when seven shares were taken up out of a capital of £15,000 in £1 shares. No calls have been made.

Easton, Anderson & Goolden, Limited (40,371).—This company filed its return on November 16th. The capital is £200,000 in £10 shares (10,000 preference); 5,996 preference, and all the ordinary have been taken up, and 12,206 are considered as paid; £37,900 has been paid on the others.

Automatic Telephone Company, Limited (53,157).—This company's statutory return was filed on November 18th, when 270,326 shares were taken up out of a capital £100,000, in 5s. shares. 226,296 are considered as paid, and 3s. per share has been called on the others. £2,579 6s. has been paid, and £4,025 4s. is in arrears.

CITY NOTES.

London Electrical Omnibus Company, Limited.

THE report of the London Electric Omnibus Company, Limited, from May 18th, 1896, to November 30th last, to be laid before the ordinary general meeting convened in London for Thursday, states that the capital account stands at £112,864, which includes 80,000 fully paid deferred shares issued to the vendor, ranking for dividend after a preferential dividend has been paid on the ordinary shares, and £20,000 paid in cash and ordinary partially paid shares also to the vendor. The expenses have been increased owing to the lack of facilities for the building and equipment of omnibuses to the contract made by the vendor as to the engagement of the engineer, to the development of the "Sola" accumulator, and to other causes. The amount of capital at the disposal of the directors not being sufficient to enable them to commit the company to the expenditure necessary either for the purchase, or lease, of suitable premises, they have had to contract for the several portions of the omnibuses with various firms in different parts of the kingdom, the engineer then putting the parts together in London, under great difficulties, in the cramped and insufficient premises which were alone at the disposal of the company. But though this course was dictated by prudence it became manifest that it would be better to find some company which would undertake to build all the vehicles which the company required, and which would contract for their delivery fully and electrically equipped in London. This being so, the directors have during several months past been negotiating for, and assisting in, the formation of the Electric Street Car Manufacturing Syndicate, Limited, which was registered on December 3rd; a contract has been made between the company and the syndicate, by which, amongst other things, it has been agreed that Major Flood Page shall accept a seat on the board of the latter, and Mr. Thomas Parker, M.I.C.E., M.I.E.E., the well-known electrical engineer, and managing director of Thomas Parker & Co., Limited, of Wolverhampton, shall accept a seat on the board of this company; this will materially strengthen the directorate, as this gentleman has a large experience of electrical manufacture. The directors had hoped to be able to announce that they had succeeded in bringing about the formation of another syndicate for the purpose of manufacturing and working the "Sola" accumulators, with an interchange of directors, as in the case of the Street Car Manufacturing Syndicate. This expectation has been frustrated owing to a claim made by the trustee in Mr. Marshall's bankruptcy, which has stopped all progress being made in the formation of the "Sola" syndicate, until the question of title thus raised shall have been decided. The directors have not lost confidence in electric street traction; but, in their opinion, it is advisable that the vehicles should be manufactured by one company or firm, such as the syndicate at Wolverhampton, and delivered in complete working order in London; and it is desirable that a syndicate should be formed for dealing in a similar way with the "Sola" accumulator; and that at least sufficient working capital should be provided in lieu of that which the vendor and his associates have failed to pay when due. There are no debentures, there are practically no debts, and the foundation for a successful business has been laid. The fact that in the short time the company has existed very little business has been done is what has happened in every new enterprise, electrical and otherwise. All that is required is that the shareholders should work together, that a comparatively small amount of money should be provided for the immediate purposes of the business, and that there should be some alteration in some of the details of the company. There is no reason for panic, least of all for winding up the company, as has been suggested. If the vendor and his associates had paid the money due on his partly paid shares the company would have had ample funds for immediate requirements. In order to arrive at the best method of raising the necessary funds, of dealing with the deferred shares, &c., the directors will be glad that a committee of shareholders shall be appointed at the meeting to consult with them on the position and requirements of the company.

A meeting of the company was held at Winchester House yesterday, Major Flood Page in the chair.

The CHAIRMAN said the meeting was being held within the legal time; their only wish to postpone the meeting being that they should be able to tell the shareholders that they had made arrangements with a company to build the omnibuses, and with another company for the manufacture of the accumulators. They had had many difficulties to contend with; they had had no proper premises, the amount of capital at the disposal of the directors not being sufficient to enable them to go to any expense in that direction. They had difficulties in having the motors manufactured. They ought to bear in mind that this was a pioneer company, and they must move slowly. They were disappointed with the progress they had made. When they started they certainly expected progress to be more rapid. Yet they had made progress, for they had solved the whole manufacturing question, which was the most difficult one they had to face. They had a 10-passenger omnibus, licensed by the Police yesterday, in addition to that they had two other busses nearly ready. The chairman then went on to speak of the Sola accumulator, in which he expressed confidence, and the expert reports spoke highly. The company was a small one, and they recognised some time ago the necessity of improving their financial position. In a speech of considerable length, the chairman urged the shareholders to help them to place the business on a sound footing.

After various criticisms the report was adopted, and a committee of four shareholders was appointed to confer with the directors.

House-to-House Electric Light Supply Company.

MR. PAGE presided over an extraordinary general meeting of the above company, held on Tuesday afternoon, in order to consider a resolution consequent on the passing of other resolutions reported in last week's ELECTRICAL REVIEW. The following resolution was formally proposed and agreed to: "That the agreement dated November 29th, 1897, and made between the company of the one part, and the several persons, corporations and firms executing the same in the schedule thereunder written (thereinafter called 'the holders of founders' shares') of the other part, be approved and confirmed; and that, having regard to the terms thereof, the capital of the company be reduced from £200,000, divided into 40,000 shares of £5 each, of which 27,900 are ordinary shares, 12,000 are preference shares, and 100 are founders' shares, to £199,500, divided into 39,900 shares of £5 each, of which 27,900 are ordinary shares and 12,000 are preference shares; and that such reduction be effected by cancelling the whole of the said founders' shares, that is to say, the shares in the company numbered 1 to 100, both inclusive."

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 26th, 1897, were £1,055; week ending December 26th, 1896, £972; increase, £83; total receipts for half-year, 1897, £25,115; corresponding period, 1896, £25,075; increase, £40.

The Liverpool Overhead Railway Company. The receipts for the week ending December 26th, 1897, amounted to £1,341; corresponding week last year, £1,304; increase, £37.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 24th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,868.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Dec. 22nd.	Closing Quotation, Dec. 29th.	Business done during week ended December 29th, 1897. Highest.	Lowest
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	101 – 105	101 –105	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5½ – 6½	5½ – 6½	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	59 – 61	60 – 62	60	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	106 – 107	108½ 109½	110	106½
3,038,020£	Do. do. Defd.	Stock	...	...	...	12⅝ – 13½	13½ – 14	14 3/16	13
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	16 – 16½	16 – 16½	16⅛	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	114 –118	114 –118	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3 – 3½	3 – 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	183 –188	183 –188	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	105 –107	105 –107	106½	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16 – 1/16	1/16 – 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½ – 9½	8½ – 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ – 19½	18½ – 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 – 5	4 – 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 – 11	10 – 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 –106 %	103 –106%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10½ – 10⅝	10½ – 10⅝	10½	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 – 17½	17 – 17½	17⅝	17⅜
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 – 19	18 – 19	18⅝	18½
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 – 104	101 –104	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	130 –133	130 –133	132	131½
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7⅞	18½ – 18⅝	18½ – 18⅝	18½	...
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	101 –105	101 –105	...	...
100,500£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	102 –105	102 –105	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	132 –135	132 –135	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	101 – 105	101 –105	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	102 –105	102 –105	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 –106	103 –106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 –111 %	108 –111%	109	108½
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½ – 12	11½ – 12	12	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17½ – 18	17⅝ – 18	17⅝	17½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10%	25½ – 26½	25½ – 26½	...	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 –105	102 –105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	52 – 55	52 – 55	53¼	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 –110	107 –110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	4 %	...	2 – 2½	2 – 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	5⅛%	6½ – 6⅝	6½ – 6⅝	6 1/16	6 1/16
15,000	Do. 5 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 – 17	15 – 17	...	...
15,000	Do. 5 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 – 16	14 – 16	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 – 6½	6 – 6½	6 3/16	...
130,765	Do. do. Nos. 119,235 to 250,000, £4 paid	5	...	...	...	4⅜ – 5½	4⅜ – 5½	...	...
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 –109	104 –109	107½	106
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16 – 11/16	9/16 – 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 – 110	107 – 110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7½ – 8½	7½ – 8½	...	...
3,381	Submarine Cables Trust	Cert.	..	...	...	136 –141	136 – 141	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¾ – 4¼	3¾ – 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 –107	102 –107	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	4½ – 5½	4½ – 5½	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 – 106	103 –106	...	...
64,256	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	9¾ – 10½	9¾ – 10½	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7½ – 7¾xd	7½ – 7¾	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¾ – 3¼	2¾ – 3¼	2⅞	...
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	106 –109	106 –109	...	...
88,321	West India and Panama Teleg., Ltd.	10	1/16%	1/16%	1 %	⅛ – ¼	⅛ – ¼	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	7¾ – 8¼	7¾ – 8¼	8⅛	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	5 – 7	5 – 7	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600	100	5 %	5 %	5 %	107 –110	107 –110	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	105 –110	105 –110	...	...
160,100£	Do. do 6 % Star. Bonds.	100	6 %	6 %	6%	100 –105	100 – 105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½ – 13½	12½ – 13½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 – 6½	6 – 6½	6⅝	6 1/16
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,377	5	5 %	5 %	5 %	10½ – 11	10½ – 11	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	113 –116	113 –116	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	26 – 27	26 – 27	26½	26¼
10,000	Do. do. Prov. Certs.	5	...	...	...	25½ – 26½	25½ – 26½	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 – 18	17 – 18	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	131 –136	131 –136	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	...	nil	nil	13½ – 14	13½ – 14	13 15/16	13½
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	...	6 %	6 %	15½ – 16	15½ – 16	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 – 10	9 – 10	...	...
10,000	Do. 7 % Cum. Pref.	5	...	...	...	11 – 11½	11 – 11½	11¼	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	5 %	18½ – 19½	18½ – 19½	...	...
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	18½ – 19½	18 – 19	18 1/16	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 –123	119 – 123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	17½ – 18½	17½ – 18½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	17 – 18	17 – 18	17⅝	17⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 – 11	10 – 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	103 –106	103 –106	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅝ – 2⅞	2⅝ – 2⅞	2¾	...
79,900	Westminster Electric Supply Corp., Ord., 10,1 to 80,000	5	5 %	7 %	9 %	16 – 17	16 – 17	16¾	...

* Subject to Founder's Shares.
† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation Dec. 22nd.	Closing Quotation, Dec. 29th.	Business done during week ended Dec. 29th, 1897. Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	16⅜ — 17¼	16⅜ — 17¼	17¼	16⅞
90,000	Brush Elecl. Engng. Co., Ord., 1 to 90,000...	8	2½%	...	...	1⅞ — 2	1⅞ — 2⅛	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	2⅛ — 2⅜	2⅛ — 2⅜	2 3/16	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	108 —112	109 —113	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	103 —106	103 —105	102½	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	...	...
143,106	Do. do. do. £6 paid	10	...	...	...	5½ — 6	5½ — 6	5⅝	5 1/16
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1 — 1⅛	1 — 1⅛	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅝	4¼ — 4⅝	...	...
630,000£	City and South London Railway	Stock	1⅛%	1 1/16%	1 1/16%	66 — 68	66 — 68	67½	67
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	2 — 2½	2 — 2½	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5 %	5½%	2½ — 3	2½ — 3	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	5½%	4½ — 5½	4½ — 5½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	2⅝ — 2⅞	2⅝ — 2⅞	2½	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3⅛ — 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	3/16 — ¼	3/16 — ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	3/16 — ¼	3/16 — ¼	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	20 — 21	20 — 21	...	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	23 — 24	23 — 24	23⅞	23⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	103 —107	106	...
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅝%	2⅝%	11 7/16 — 11 9/16	11½ — 11⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	38¼	37
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	12½ — 13	12½ — 13	...	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 80% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1891—7%; 1896—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

***Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.**

Electric Construction Corporation, 6 % Debentures, 104—106.

House-to-House Company, 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 15—15½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 2½—2⅝.

***T. Parker, Ltd., £10 (fully paid), 12¼.**

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8¼. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

SAFE CARRYING CAPACITY FOR ELECTRICAL CONDUCTORS.*

By C. H. SEWALL.

(*Concluded from page* 885.)

For a gutta-percha covering it is supposed that radiation will be better than with rubber. Prof. Forbes makes the proportion of thermal conductivity as 48 to 41 in favour of gutta-percha as compared with rubber.

It is also highly probable that a conductor with an ordinary wall of insulating material encased in lead, will bear more current than if protected by rubber or gutta-percha alone. Mr. Fisher, of the Standard Company, placed upon a wooden floor four cables running side by side in the form of an elliptical spiral. Unfortunately, full data are not given, but the calculated tables from the experiment show, for a rise in temperature of 25°, about the same figures as the national code, and as the cables lying side by side must have heated one another, it is a fair inference that their radiating properties under even conditions are rather better than for bare wires. Undoubtedly, cables suspended in air will carry much more than the code allows. If underground much will depend upon conduit ventilation.

After heat has been brought to the surface of a conductor and is radiating therefrom, it causes the particles of air in its vicinity to move away and to be replaced by others, which are again moved and replaced, and so on. This process is called "convection."

* Read before the Chicago Electrical Association, November 5th, 1897.

The experiments of 1889 showed that a No. 10 B. & S. bare copper wire in a room from which drafts of air have been carefully excluded, will be raised in temperature 18° F. from 75° F. by 26 amperes, and will require 42 amperes to bring it to the same temperature if the wire be suspended out of doors upon a calm summer day.

In a room guarded against outside drafts the agitation of a fan near a current-bearing wire sensibly decreased its temperature elevation.

The influence on radiation from convection, and from colour also, may be seen by grouping figures from experiments for No. 0000 B. & S. gauge under four different conditions, viz.:

	Amperes.
Bright bare copper in a room with still air	162
Blackened bare copper in a room with still air ...	200
Bright bare copper out of doors, calm weather ...	322
Blackened bare copper out of doors, calm weather ...	340

starting with the same temperature elevation and attaining the same rise.

The influence of extent of radiating surface is shown by comparing code allowances for the same cross-section; first, in one conductor No. 0000 gauge, 210 amperes; second, in two conductors of one naught gauge, 254 amperes, 21 per cent. increase.

The percentage increase from one 2,000,000 circular mils conductor to two of 1,000,000 circular mils each is from 1,050 to 1,300 amperes, or nearly 24 per cent.

It may be convenient to remember that with large conductors there can be gained from 20 to 25 per cent. in cooling effect by making a lead of two conductors of one-half the cross-section required, instead of using one conductor with the whole cross-section required.

While convection is not directly proportional to radiating surface, it seems to be to length, and Mr. Kennelly gives as

an approximate rule that in still air the loss of energy due to convection has a mean value of 0·00175 watt per linear centimetre for each degree Centigrade of temperature elevation, or one kilowatt for every 114 metres at 50° C. temperature rise.

Different quantities of heat are required to raise the temperature of a given weight of different substances a certain number of degrees. This is called specific heat. For the reason that the specific heat of iron is 25 per cent. greater than that of copper, we may expect to find that iron wires safely carry more current than is indicated by their compared resistance with copper for the same cross-section.

For metals other than copper, I have been able to find but little information. Mr. Preece in 1888 furnished very complete data on fusing effects, but as these involve the capacity of the metal to resist melting, they are not reliable guides to effects of moderate heat. In a catalogue issued some years ago there are tables for carrying capacity of iron. These give for the equivalent in cross-section of No. 10 B. & S. in galvanised iron wire a maximum safe current of 12 amperes; for tinned wires, 12·3 amperes. These figures are about one-half the code allowance for same size rubber-covered copper wire. The resistance given in the same table ($6\frac{1}{2}$ times that of copper) indicates a low grade, electrically, of iron wire.

In the same book German silver, No. 10 B. & S., having a resistance $16\frac{2}{3}$ times greater than copper, is allowed a safe carrying capacity of 8·5 amperes. The 16 per cent. German silver wire usually found in the market of to-day has a resistance 18 times that of copper.

No further explanations as to conditions accompany the table just mentioned.

It is a law that the temperature of a conductor increases as the square of the current strength if the resistance is constant. As temperature rises resistance increases; but it is also the fact that greater activity in radiation and convection tend to offset the effect of higher resistance, and experiments have shown that, in a wire which is given a fair chance to part with its heat, the rule approximately holds good for an indefinite time.

For the same reasons and under the same conditions, with a given rise in temperature the square of the current varies as the cube of the diameter of a round wire.

The law governing safe temperature of a round wire is expressed by the formula $C = a\,d^{\frac{3}{2}}$, where C is the proper current in amperes, d diameter, a the constant which is applied to suit conditions under which the wire is to be used. Kennelly's constant for insulated wire in moulding is 560, if d be in inches.

Solid No. 0000 B. & S. is ·46 inch diameter. That figure raised to the $\frac{3}{2}$ power is ·312; ·312 × 560 = 174·72 amperes, which was for a long time the underwriters' rule for No. 0000.

As the limit has been raised to 212 for rubber-covered wires, it follows that the present constant is 212 ÷ ·312, or 680 (nearly), and for weather-proofed wires 312 ÷ ·312, or 1,000.

For stranded conductors let us consider a familiar size, 500,000 circular mils, which by the latest catalogue (Roebling's) is of a diameter ·819. For ease in computation call it ·82 (for neither stranding nor carrying capacity are as yet exact sciences); $(82)^{\frac{3}{2}}$ is ·742. Code amperes for 500,000 circular mils are 390, which divided by ·742 gives 526 as the constant for rubber-covered strand. A similar process will show 800 to be the constant for weather-proof strand.

It will be noted that the constants for stranded conductors are smaller than for solid ones.

This is because the diameters for strands are larger, in proportion to resistance, than for solid ones.

Previous to issuance of the present code, the only rule as to stranded wires that I was able to find was given in an English publication by Stuart A. Russell on electric light cables. Speaking of Mr. Kennelly's constant for solid wires (560) he said: "When stranded conductors are used it must be remembered that their resistance is about 28 per cent. greater than that of a solid conductor of the same length and diameter, owing to the loss of space in stranding; and, therefore, the formula given must be modified so as to take this into account. It is evident that the same amount of heat will be generated whether the current, C, is passed through a resistance, R, or a current

$$\frac{C}{\sqrt{1{\cdot}28}}$$

is passed through a resistance 1·28 R, and, therefore, for stranded wires the constant 560 must be divided by

$$\sqrt{1{\cdot}28},$$

making the formula $C = 500\,d^{\frac{3}{2}}$."

Acting upon this suggestion the writer, some years ago, calculated a table for strands. Apparently, English manufacturers made their strands smaller in diameter than the Americans, and my constant figured 487 instead of 500. But it was questionable whether air in the inter-spaces of a strand would not so retard radiation as practically to counteract effect of larger outside surface.

Mr. Merrill's results have demonstrated that there is a counteracting influence, for the constant of 487 corrected by results of experiments becomes 434 for a limiting current of 174 amperes for 0000 (the old rule).

It is probable that there is neither gain nor loss, so far as heating effect is concerned, by making conductors in concentric strands. This is corroborated by an examination of the published code. We find that 200,000 circular mils stranded conductor is allowed 200 amperes, or one per 1,000 circular mils, and that a No. 0000 solid conductor of 211,600 circular mils is allowed 210 amperes, or very nearly in the same ratio. There may be advantage in using the cable form; but it is doubtful.

Prof. Forbes, at one time, seriously proposed the use of flat strips for underground conductors, but he overlooked the fact that large surface means great increase in cost of insulation. In those days the wires were buried in the ground without the use of conduits, a condition very unfavourable to active convection. We can all remember that but a few years ago conduits were not ventilated except as the manhole covers, from time to time, acted automatically.

All data so far given in this paper are based upon the action of direct current. There can be no doubt that the heating effect of alternating current, especially in large conductors, must be considerably greater than if direct current is used. But I have no information on the subject, and will not weary you with speculation.

SIEMENS & HALSKE'S TELEPHONE CABLES.

THE rapid extension of telephony has led to the extensive use of underground cables in addition to the overhead cables orginally employed. These cables contain a large number of separate insulated conductors pressed into the smallest possible space. Neglecting those made for special requirements, the telephone cable of to-day is an air space cable, composed of copper wires insulated from one another by paper wrapped loosely round them, all these conductors being combined into one cable and enclosed in a water-tight lead tube.

Telephone cables may be divided into two great classes, those with single conductors, and those with double conductors.

Cables with single conductors are used where there are no strong external electrical disturbances to be feared; but each strand has to be protected from the inductive action of neighbouring strands by coating it with tinfoil.

Chiefly on account of the recent great extension of electric traction, cables with double conductors have become more and more a necessity. In these cables a pair of conductors forming part of one circuit are laid close together, and by this means induction from adjacent conductors, and from external sources, is completely screened off.

The lead protective coating is the same for both kinds of cables, but its make varies somewhat according to the kind of cable. The different kinds of cables may be classified as air cables, earth cables, canal cables, and river cables.

The following is a short description of the leading types of telephone cables manufactured by Messrs. Siemens and Halske:—

1. The telephone air cables are simply wrapped round with tape over the coating of lead, since these cables are not

usually liable to mechanical shocks. These cables are either fixed to walls or posts, or suspended free in the air. In the latter case the cable is supported by a steel wire rope, to which it is connected by bell insulators. Fig. 2 represents the section of an air cable with 28 single conductors.

2. The telephone earth cables possess a complete armour. This consists either of iron hoop or flat wire, it is separated from the lead coating by a cushion of soft insulating material, and is protected externally by a coating of asphalt. Such cables can be laid directly in the ground, since they are sufficiently protected against mechanical shocks and chemical

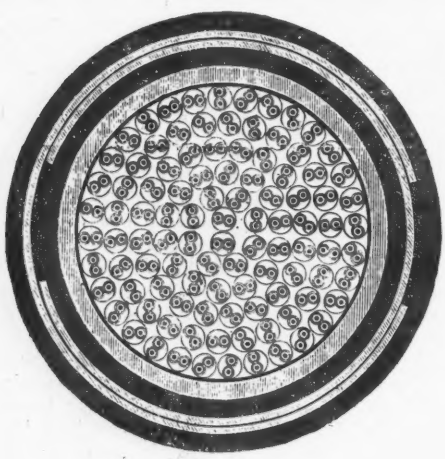

Fig. 1.

corrosion. Fig. 1 shows a section of a telephone earth cable with 102 double conductors, and asphalted iron hoop armour. Fig. 3 is a 56 strand single conductor cable with flat wire armour. Fig. 4 is a cable with 28 double strand, and fig. 5 a telephone earth cable with two double strands.

3. Telephone canal cables. Since the digging up of streets in large towns is expensive and disturbs the traffic, telephone cables can seldom, in such places, be laid directly in the ground. It becomes necessary, therefore, to lay such

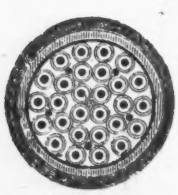

Fig. 2.

Fig. 5.

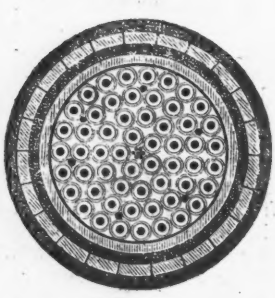

Fig. 3.

Fig. 4.

cables in pipes or canals which are gradually filled up as more cables are required. There are two kinds of canals which each require a special kind of armour on the cables.

The first is that in which a large number of cables is laid in one and the same canal. In this case the lower cables have to bear the superincumbent load of the cables above, and the armour must, consequently, be made sufficiently strong for this purpose. The cables must also have a smooth surface, so that they can be drawn easily into or out of the canals. They are, consequently, usually enclosed in flat wire armour, separated from the lead coating by a soft insulating layer, and laid close together so that the surface is everywhere smooth.

In the second canal system, a special canal is used for every cable, or a few cables are laid side by side in one canal. In both these cases the cables may be protected with half armour or left bare. The half armour consists of steel wires (the number depending on the tensile strength required) which are wrapped round the cable, being separated from the lead coating by a layer of soft insulating material. These wires form sufficient protection for the lead coating when the cables are being drawn into or out of the canals. If the cables are to be laid with armour, the lead coating must be made somewhat thicker.

4. Telephone river cables. These differ principally from the cables described above in having a double coating of armour which separated from the lead coating by a double layer of soft insulating material, and protected outside by a coating of asphalt. In heavy cables of this class, there is also a layer of the soft insulating material between the two coatings of armour. The heavy cables are laid where there is risk of injury to the cables from dragging anchors.

THE MANAGEMENT OF BOILERS AND STEAM PLANT, INCLUDING DETAILS OF STEAM PIPES AND FITTINGS.*

By A. B. MOUNTAIN, Borough Electrical Engineer, Huddersfield.

(*Concluded from page* 916.)

There is, however, an important point often overlooked when considering an economiser or steam superheater and its value, and that is the draught of the chimney. It is perfectly clear that if the temperature of the gases at the base of the chimney is lowered from 600 to 250°, the draught of the chimney must also be very considerably reduced. There are many who hold the opinion that the temperature of the gases at the base of the chimney should not be below 400° Fahr. In the author's opinion it is advisable to have a forced draught and let the heated gases be drawn more slowly away, and that the heat utilised in raising the temperature of the feed water is productive of greater economy than if allowed to increase the draught of the chimney.

Having decided to adopt water-tube and Lancashire boilers, it is necessary to arrange the fittings, and the question as to whether the boilers should be fired by hand or with mechanical stokers. Closely connected with this is the question as to what kind of fuel is to be used. It may be considered as settled that smoke in any considerable quantity will not be permitted to rise from the chimney top. With water-tube boilers it is difficult to stop smoke, if hand fired, unless a very hard steam coal can be obtained. The flames rising from the fire come into contact with the cool tubes, and are to a great extent extinguished, causing smoke. If coke can be bought at a reasonable price, excellent results may be obtained, and the smoke nuisance entirely removed; but coke has the disadvantage of requiring a very thick fire to stop the air rushing through, and a considerable quantity is usually thrown into the furnace when firing. This cools down the boiler, and reduces for a short time the generation of steam. Then when the charge is being rapidly consumed, the steam is generated at a very rapid rate; if one boiler is used, it therefore requires careful firing to keep a steady steam pressure, but if several boilers are used in combination, it is very easy to fire alternately. If coke cannot be obtained cheaply, and the ordinary bituminous slack has to be used, it is necessary to fix mechanical stokers, otherwise there will be considerable trouble with smoke, and in the author's opinion the coking form of stoker is the only form which can be fixed to a water-tube boiler with any certainty of success. The firing of the Lancashire boiler does not require the same care as the water-tube, as the flame from the fire passes over the bridge and helps to ignite any gases which may be passing away unconsumed, and as the flues are connected underneath the boiler, the flame from one fire assists in the combustion of the gases from the other fire. Mechanical stokers have, however, a great advantage over hand firing, in the fact that the class of fuel may be very considerably reduced in quality and consequently in price. It is not necessary to fix the coking form of stoker upon a Lancashire boiler; the sprinkling form of stoker will do equally well, and has certain advantages. It more easily admits of the fire being forced, which in an electricity works is an important point. The heat generated is distributed over the whole length of the bar, whereas in the coking form of stoker the heat is confined to a small portion of the fire, and the damage to the bars is considerable; and the author is of the opinion that the maintenance of the coking stoker is considerably higher than the maintenance of the sprinkling type.

There are many other patent furnaces in which it is claimed exceedingly good results may be obtained. In most of these a jet of dry steam is blown through a nozzle or pipe acting as an injector,

* Northern Society of Electrical Engineers, December 13th, 1897.

and increasing the pressure of air underneath the fire. This undoubtedly increases the rate at which the fuel may be consumed, and the steam passing through the fire forms water gas and adds considerably to the heat. If fuel of a very poor quality is to be consumed, a furnace of this type may with advantage be employed, but the author is not sure that there is not a limit to the heat which may be usefully employed in the furnace, and that harm is done to the plates or tubes if this is exceeded. From actual experience he had found damage result from such a furnace when employed in connection with a water-tube boiler.

While considering the firing of boilers it may be well to notice some of the large number of so-called smoke-consuming devices. These, in many cases, are simply arrangements for admitting a large quantity of air, which only dilutes the smoke and reduces the heat of the furnace gases, and it is well to be very careful before adopting these arrangements. Undoubtedly the results in a furnace in which coke is used can be very much improved by the admission of a secondary supply of air, but this should be supplied to the top as well as the bottom of the fire, and should, if possible, be hot, and so arranged that the air may be admitted in varying quantities. If it is proposed to adopt a furnace of this kind, having a secondary air supply, it is advisable to fix an instrument which will indicate at any moment the condition of the gases leaving the furnace, and consequently show when the air should be admitted and in what quantity. It is no doubt unnecessary to point out that theoretically the gases leaving the furnace should consist of as much carbon dioxide as possible, together with water vapour and nitrogen. This it is, however, impossible to obtain in practice, and it will usually be found that the best results are obtained when about 20 per cent. of carbon dioxide is present, but the author would strongly urge the importance of employing any one of the many methods of recording the condition of the gases leaving the furnace. An excess of air simply reduces the temperature of the gases, and reduces the evaporative results. On the other hand, if there is not enough air the oxygen required for complete combustion is restricted, and carbon monoxide is allowed to leave the furnace without being converted into carbon dioxide.

The use of induced draught instead of forced has lately been tried in connection with marine boilers at some electricity works, with apparently satisfactory results. It is, however, questionable whether the draught induced by a fan drawing away the products of combustion at an extremely high temperature, and therefore much expanded, could not be more economically produced by a steam jet. Undoubtedly the idea of introducing hot air instead of cold is one of the causes of the success obtained with induced draught, and the author has found that this may be readily accomplished either with the water tube or Lancashire type of boiler by forming a division in the walls of the boiler seating, through which the cold air passes on its way to the furnace. This not only heats the air, but keeps the outer wall of the seating cool, and thus prevents wasteful radiation of heat.

The subject of coal elevating and conveying machinery, although somewhat outside the scope of this paper, is too interesting to be passed without comment. The first question to decide is, when it will be advisable to put in elevating and feeding machinery. The author is of opinion that it should not be fixed until the work exceeds the power of three men upon the heavy shift, or, in other words, until the wages saved will go a considerable way towards paying the interest upon the capital expended. As to the most suitable arrangements for feeding the fuel to the hoppers of the stokers, this must depend to a very large extent upon the arrangement of the works, and the manner in which the fuel is delivered to the works. Whatever method is adopted, the fuel should be weighed into each hopper in the same manner as the coal in a gas works is weighed and fed into the retorts, and if ash elevating arrangements are devised, it is most desirable to know exactly the proportion of ashes per ton of fuel used.

Probably the fittings attached to a boiler are the most serious cause of annoyance, and it is scarcely possible to over-estimate the importance of them. The same fittings are required for all boilers, the size depending upon the evaporative power of the boiler, and it is surprising to find the different classes which are in use. Commencing with the water gauges, there should in all cases be two on each boiler, so that the correct level of the water may be obtained. These should be so constructed that if a glass is accidentally broken, the steam and water which would rush out will be instantly stopped. The gauges should also be protected, so that the pieces of glass are allowed to fly outwards. High and low alarm valves, and steam safety valves, should all be of ample size; no greater mistake can be made than in reducing the size of a safety valve.

The main stop valve should be large, so that the steam does not have to leave the boiler at a high speed. Small valves are frequently the cause of water being carried with the steam into the steam pipes. It has been suggested by some makers of fittings that it is desirable to fix another valve adjoining the main stop valve, for the purpose of stopping the steam being admitted accidentally into a boiler in which a man might be working. There have been several accidents of this kind, and a really reliable valve for isolating purposes would be useful. Unfortunately, the steam usually leaves the boiler in short pulsations corresponding to the periods of admission to the engines, and these pulsations cause a valve to speedily knock itself to pieces, or, at any rate, to damage its face and seat so badly that it is not steam tight. Two feed valves should be arranged for each boiler, so that any accident will not stop the supply of water, and it is of course desirable to arrange the feed pipes in the ring form, or with two distinct ways of feeding.

A blow-off valve must be fixed to each boiler, and the author has found it extremely desirable to have these so arranged that they can be very easily inspected. It is very usual to connect the blow-off valve with the drain, and if this is done it is impossible to tell if the valve is leaking; and in addition to this undesirable contingency, some fatal accidents have taken place owing to the blow-off valve of each boiler being opened at the same time, allowing the steam from one boiler to get back to the other, and scald the men employed cleaning. This trouble has led to the introduction of many ingenious arrangements to avoid the danger of leaving the valve open, but in the author's opinion they should be quite unnecessary, and only add considerably to the expense and complication of the fittings, which should be devoid of as many refinements as possible.

The chief trouble with high pressure steam fittings is caused by the expansion due to the high temperature of the steam. It is very usual to see fittings quite tight with a water pressure and also with a low steam pressure, but quite unfit for employment with a pressure of 150 to 200 lbs. per square inch, and the author has found it advisable to insist upon all fittings being tested with steam to a pressure considerably above that at which they are required to work.

It should be a rule in any well-managed works that all fittings should be carefully examined and cleaned at least every 12 months, and unless this is done even the best fittings will prove unsatisfactory.

Having arranged the class of boiler, method of firing, and fittings, the next step is to convey the steam to the engines, and it is again evident that in an electricity works some special method must be devised so that the supply may never be interrupted by the failure of the joints, pipes, fittings, &c.

Roughly summed up there are three systems in use:—

1. The single main, with the boilers feeding in and the engines drawing out.

2. The ring system, so arranged that any section can be disconnected.

3. The twin system, with two ways of supplying each point.

All these methods have advantages for and against them, and it is more or less a matter of choice which should be adopted. The first, in the author's opinion, is not sufficiently safe to be employed where continuity of supply must be considered as the first requirement.

The size of the main steam pipe is also an important point; as the size increases the condensation becomes greater. It is quite possible to arrange feeders to the points where the supply is required, and by doing this reduce the size of the ring. The feeders being opened only upon heavy loads considerably reduces the condensation, which even in a small works is an exceedingly costly item. The author has found it desirable to place receivers having considerable capacity close to each engine. These act as steam dryers as well as maintaining the pressure, and as they are only in use while the engine is running, they do not, therefore, add considerably to the amount of condensation.

It is of course most desirable to arrange all valves upon branches, so that they stop the supply as close as possible to the main, and thus reduce the length of live pipe, as well as leave the engines' cylinders cool for inspecting purposes.

The pipes should be free to expand, and it is absolutely necessary either to arrange large bends or expansion joints for this purpose.

The drainage of steam pipes is a subject upon which another paper might easily be written. There are innumerable steam traps designed to allow the water to readily flow away, but the author is surprised that the American method of dealing with this difficulty has not been more generally adopted in England, as it is most desirable to conduct the hot condensed water back to the boiler if possible without the help of a pump. One of the American methods employed may be very briefly described. It consists of a small pipe, the one end being connected to the steam pipe at the point from which it is desirable to drain the water, the other end being led direct to the boiler. Supposing that the boiler pressure was 150 lbs. per square inch, and the pressure upon the steam pipe at the point desired to be drained 145 lbs. per square inch, it would be necessary to allow the pipe to rise, say, 12 feet above the water level in the boiler to enable the water to return to the boiler, a check valve being arranged at the top of the pipe, so that the water can go into but not return from the boiler.

In conclusion, the author would point out a few of the difficulties he has experienced in working with water-tube boilers, under the conditions stated in this paper.

The cracking of the brickwork seating, and consequently the admission of cold air, has been a source of considerable annoyance, and the author is not aware of any method of construction which will prevent this, although several different methods have been tried.

The firebrick lining of the boilers will also require constant renewal, and the author has found large firebrick slabs placed at the side of the furnaces last much longer than brickwork, and are more easily replaced.

After the boilers had been at work some time, it was found that a considerable amount of pitting was taking place. This was due to the soft condensed water, and was stopped by limewashing the whole inside of the boiler, or by admitting lime with the feed water; but if the latter course is adopted, care must be taken to admit only a small quantity of lime, or a deposit in the form of scale will form on those portions of the boiler subjected to the greatest heat.

The admission of oil with the feed water is, however, one of the most serious difficulties the author had to overcome. There are many forms of filters which may be used. These consist generally of Turkish towelling, or cocoanut matting, wrapped round a perforated cylinder or plates, and are fixed upon the feed pipes so that the water entering the boiler is compelled to pass through the filtering medium. Another class of filter may be used, in which coke or sawdust is employed as the filtering medium; but the author has found that the great point against any form of filter fixed upon the feed pipes is that the water is passing through the filtering medium at too great a velocity, and he has found that if a filtering tank is placed under the

condenser into which the hot water flows, and the water allowed to pass through a much larger area of filtering material at a very slow speed, much more satisfactory results can be obtained; but even with a duplicate arrangement, oil will find its way into the boiler in small quantities, and the boilers must be frequently cleaned. Although cleaning a boiler once every month or six weeks may entail considerable expense, it is to a large extent returned by the increased evaporation. The importance of keeping boilers thoroughly clean cannot be over-estimated, and in the author's opinion this is the greatest cause of the difference in the figures obtained when testing, and this applies to all types of boilers.

The great aim of the engineer in charge of the works will be to obtain the most steam at the least cost, but, unfortunately, it is hardly possible to make a satisfactory comparison, because the cost of fuel varies very considerably, and it may be that the engineer with a high figure for fuel is really working more economically than another engineer whose figures are much lower, owing to the fact that the price of coal depends largely upon locality. In an electricity works, owing to the very varying demand, a very large proportion of the fuel is used for banking up fires in reserve boilers. It would, therefore, seem advisable to employ the poorest class of fuel possible to be obtained, provided it can be delivered to the works at a very cheap rate, in preference to burning less fuel of a more expensive kind. The author has found, from careful tests, that the cost of fuel per pound of water evaporated depends almost entirely upon this question of price, and not upon quality. But if poor fuel be employed, more boilers will be required, and it may easily happen that the capital charges upon the additional boilers will outweigh the small advantage gained from the use of poor fuel.

The author would finally express his regret that he has only been able to touch upon the outskirts, as it were, of this important subject, which affords ample scope for deeper research and opportunities for some most interesting experiments, and although he feels that there is nothing in this paper of which those present are not fully aware, he yet hopes that this subject which he has had the honour of bringing before them may be the means of inducing an interesting discussion upon this important question.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

29,427. "Improved electric arc lamp." H. V. James. Dated December 13th.

29,429. "Improvements in electrical controlling apparatus." W. Emmott. Dated December 13th.

29,493. "Field telephone and telegraph station." M. Bernstein. Dated December 13th. (*Complete.*)

29,505. "Improvements in magnetic telegraphy." O. J. Lodge. Dated December 13th.

29,507. "Method of, and apparatus for, producing perforated accumulator plates." M. Engl. Dated December 13th. (*Complete.*)

29,523. "Improved electrical means for preventing burglaries, for external and internal use." C. Bannister. Dated December 14th.

29,528. "Improvements in electric lights." J. Atkinson. Dated December 14th.

29,530. "Improvements in the lighting of miners' safety lamps, and the like, by electricity." H. Davis. Dated December 14th.

29,542. "Improved electric storage batteries." J. W. Davies and D. Lock. Dated December 14th.

29,566. "Improvements in, and connected with, electric motors, partly applicable to dynamos." S. W. Maquay. Dated December 14th.

29,575. "An adjustable electric light fitting with improved detachable rotary contacts." A. E. A. Mortimer and W. J. Head. Dated December 14th.

29,585. "Improvements in methods of, and means for, regulating alternating current dynamo-electric machines or distribution systems." The British Thomson-Houston Company, Limited. (E. W. Rice, Jun., United States.) Dated December 14th. (*Complete.*)

29,586. "Improvements in, or relating to, electrical transformers." The British Thomson-Houston Company, Limited. (W. S. Moody, United States.) Dated December 14th. (*Complete.*)

29,587. "Improvements in, and relating to, dynamo-electric machines and electric motors for electric railways." The British Thomson-Houston Company, Limited. (E. D. Priest, United States.) Dated December 14th. (*Complete.*)

29,588. "Improvements in the method of, and means for, breaking alternating current induction motors." The British Thomson-Houston Company, Limited. (E. W. Rice, Jun., United States.) Dated December 14th. (*Complete.*)

29,589. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (E. Thomson and C. E. Harthan, United States.) Dated December 14th. (*Complete.*)

29,590. "Improvements in, and relating to, dynamo-electric machines and motors." The British Thomson-Houston Company, Limited. (E. D. Priest, United States.) Dated December 14th. (*Complete.*)

29,595. "Improvements in electric heaters or rheostats." F. Kraemer. Dated December 14th. (*Complete.*)

29,596. "Improvements in combination plugs or lamp heads for electric lamps." J. F. Gates. Dated December 14th. (*Complete.*)

29,597. "Improvements in controlling devices for electric motors." H. H. Lake. (H. See, United States.) Dated December 14th. (*Complete.*)

29,615. "Improvements in electrical switches or variable resistances." W. B. Spikins and A. H. Mayne. Dated December 14th. (*Complete.*)

29,651. "Improvements in and relating to joints for derrick legs, telegraph poles, and the like." F. Baker. Dated December 14th.

29,665. "Improvements in commutators for telephone plants." G. Ritter. Dated December 15th. (*Complete.*)

29,667. "Improvements in or applicable to switches for electromotors and the like purposes." J. P. Hall and W. H. S. Craven. Dated December 15th.

29,676. "A union box for electric mains for lighting traction power or other purposes." F. G. Black. Dated December 15th.

29,710. "Improvements in accumulators." D. Brown and P. Kamperdyk. Dated December 15th. (*Complete.*)

29,726. "Improvements in electric heating devices." F. Leroy. Dated December 15th. (*Complete.*)

29,778. "Improvements in telegraphy." L. B. Miller. Dated December 16th.

29,821. "Improvements in electric heaters." F. W. Schindler-Jenny. Dated December 16th.

29,826. "Improvements in conductors for electrical machinery, and in dynamo-electric machines, motors, and other electrical apparatus." J. Millis. Dated December 16th.

29,834. "Improvements in the construction of single-phase alternate current motors and generators." A. C. Heap. Dated December 16th.

29,835. "Improvements in and relating to electric heaters." E. F. Porter. Dated December 16th. (*Complete.*)

29,825. "A new or improved underground duct for electric railway leads, and a contact slide to work therein." H. T. Hellischer. Dated December 16th.

29,977. "Improvements in electric motors and dynamos." C. B. Crawshaw and C. W. Hill. Dated December 18th.

29,981. "Improvements in electric drilling machines, electric boring, and electric milling machines." W. H. Allen, Son & Co. and J. W. Kempster. Dated December 18th.

29,985. "The patent detachable collar electric incandescent lamp." F. Nicholson. Dated December 18th.

29,994. "Improvements in and connected with electric locomotives." W. E. Heys. (J. J. Heilmann, France.) Dated December 18th. (*Complete.*)

30,001. "Improvements in railway aero electric brakes." C. Luyers. Dated December 18th. (*Complete.*)

30,020. "Improvements in prepaid electric meters." A. Soanes and C. W. S. Crawley. Dated December 18th.

30,037. "Improvements in electric arc lamps." (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 21st, 1897, being date of application in France.) D. Lacko. Dated December 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

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15,447. "A brush holder to be used on dynamos and motors." G. E. Francis. Dated July 13th, 1896. Brush holders. The brush box slides upon an arm forming part of a bracket which is adjustably mounted on the spindle. A spring, capable of being adjusted by a screw-threaded rod engaging in a lug on the back of the brush box forces the brush against the commutator.

15,834. "Improvements relating to the electrolysis of soluble salts especially applicable for the production of chlorine." A. J. Outhenin-Chalandre. Dated July 17th, 1896. To prevent secondary reactions as when it is desired to obtain pure chlorine—chlorine free from oxygen compounds—by electrolysing soluble salts, such as a solution of sodium chloride, a corresponding amount of hydrogen is continually introduced into the anode space to combine with the liberated oxygen. The hydrogen may be introduced as hydrochloric acid.

16,152. "Apparatus for controlling electric currents." J. Estrade. Dated July 21st, 1896. The object is to prevent the consumption, by a subscriber, of more current than that to which he is entitled. A lever, supported on knife edges, carries contacts dipping into mercury cups at each end. The lever has a depending iron block which forms an armature to an electro-magnet. The lever and magnet are in series with the circuit to be governed. Should the circuit exceed the amount for which the apparatus is set, the armature is attracted and the lever oscillated, so breaking the circuit (or opening a shunt circuit). The case is secured by pins and sealed to prevent tampering with.

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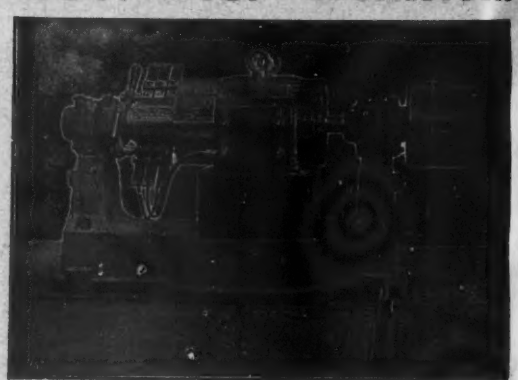

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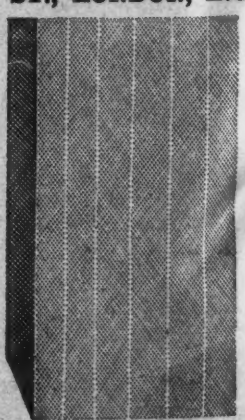

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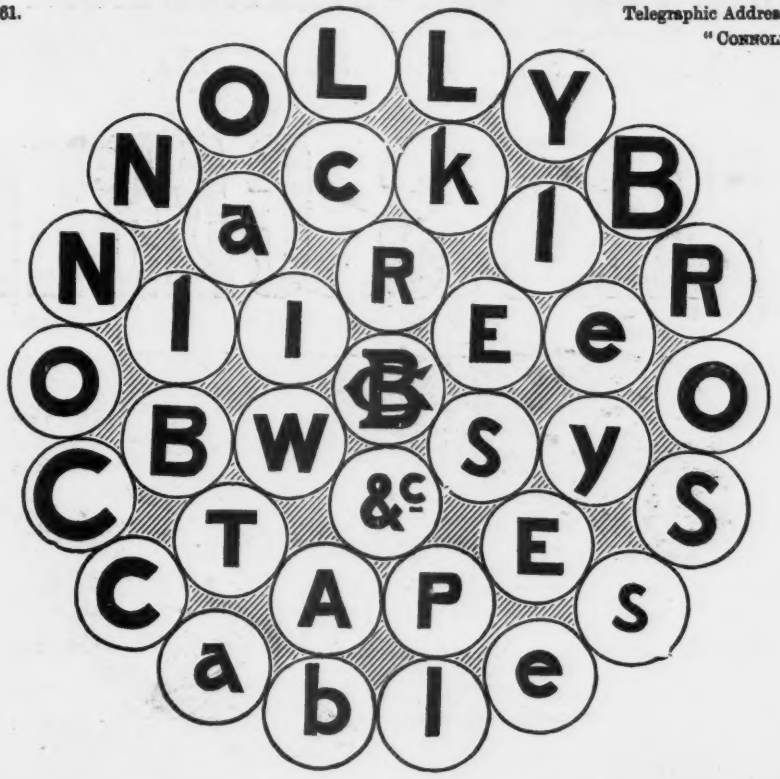

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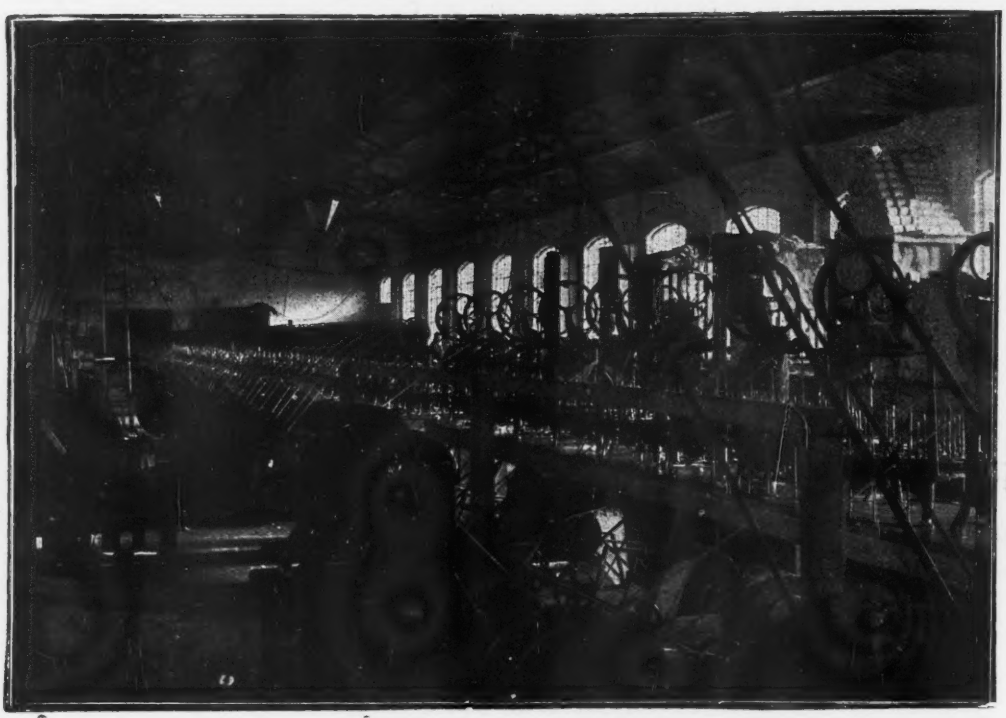

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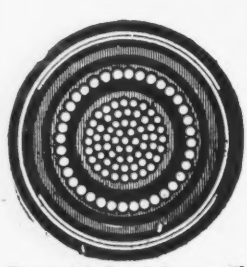

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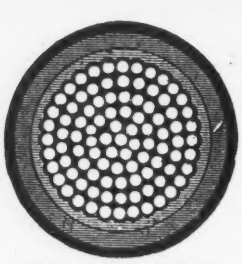

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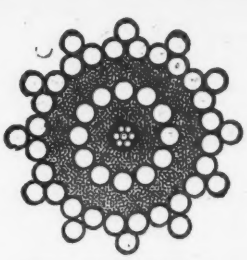

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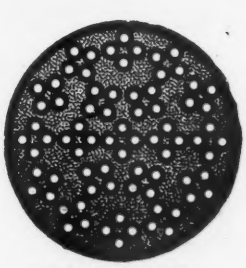

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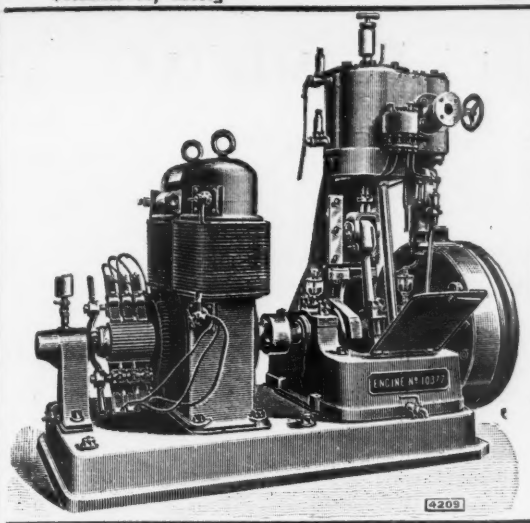

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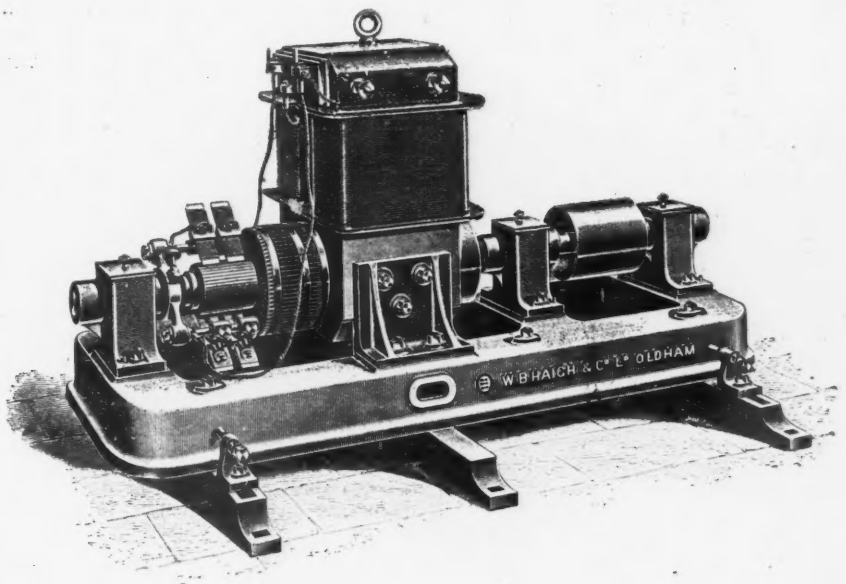

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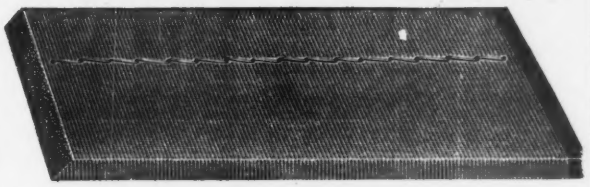

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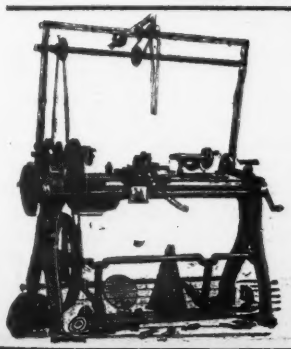

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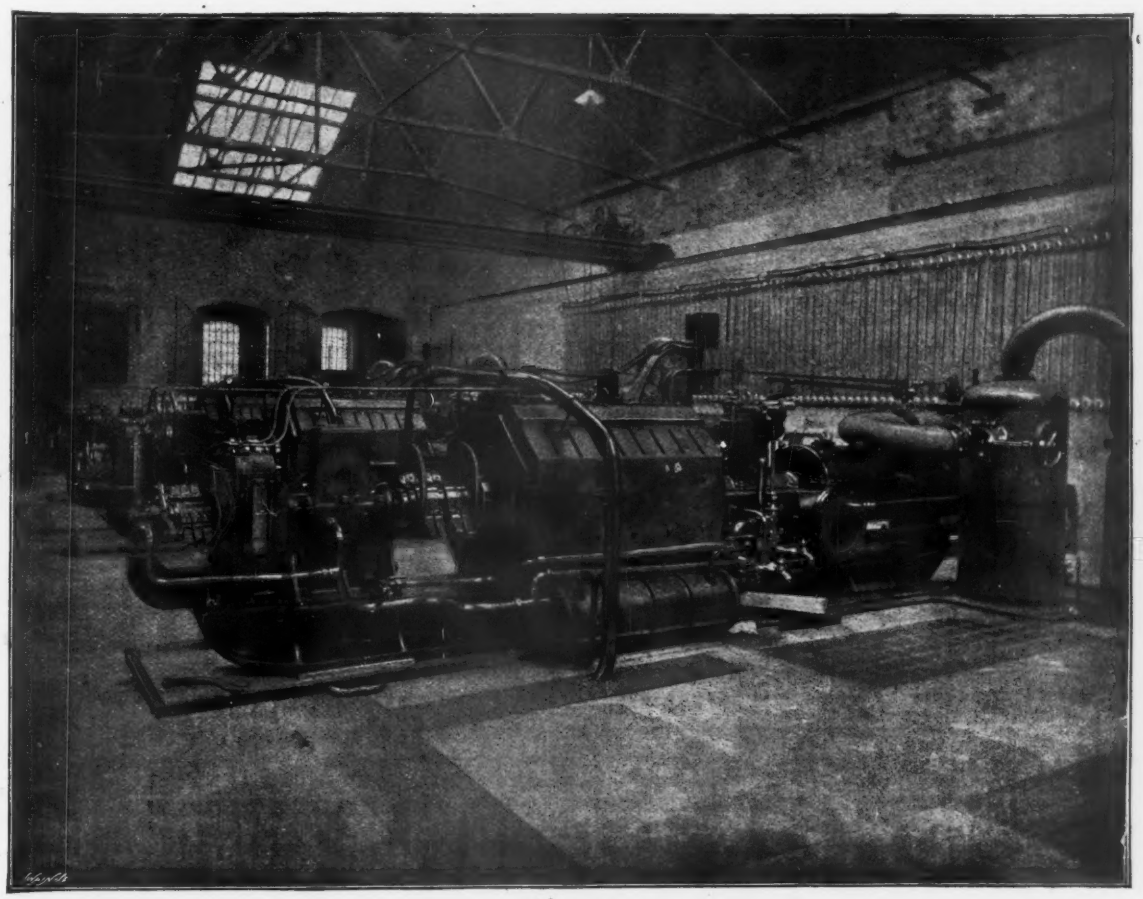

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Phosphor Bronze Wire, Rods, Sheets, Tubes, &c.; Bearings, Bushes, and other wearing parts of Machinery. Babbitt's and other Anti-Friction Metals.

Patent Silicium Bronze Wire of great tensile strength and high conductivity. H.C. and ordinary Copper Wire. Rolled and Drawn German Silver and Brass.

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SOLE MAKERS OF

BULL'S METAL,

FOR

CASTINGS, FORGINGS, RODS, SHEETS, AND STAMPINGS.

1943

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12, Wharf Road, City Road, London, N.,

TELEGRAPH AND PNEUMATIC ENGINEERS AND CONTRACTORS

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COMPLETE ELECTRIC LIGHT INSTALLATIONS.

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Manufacturers of Submarine Cables, Wire, Iron Poles, Instruments, Batteries, Insulators and Stores of every Description. 112

HIGH-CLASS ANTI-CORROSIVE

LUBRICATING OILS.

FOR CYLINDERS, HEAVY BEARINGS, AND MACHINERY OF ALL KINDS.

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CYLINDER OIL, MACHINERY OIL, | **GAS-ENGINE OIL, DYNAMO OIL.**

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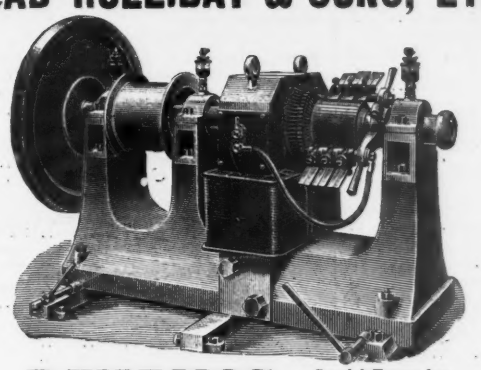

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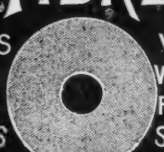

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68. 69. 70 & 71

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The Brush Uncased.

THE "SPARKLESS GEM"

DYNAMO AND MOTOR BRUSH.

(Chaplin's Patents.)

As Supplied to the Leading Municipal Electric Light Stations throughout the United Kingdom.

MADE OF No. 36 B.W.G. HIGH CONDUCTIVITY COPPER WIRE.

The peculiar construction of this Brush ensures perfect contact with the Commutator, even when much worn; and renders it so superior in all points to the older types of brushes that it is rapidly displacing them for Dynamo and Motor work of every kind. The result is brought about by the spongy nature of the contact surface. With the lightest possible pressure the highest conduction is attained, sparking is prevented, wear on the commutator is reduced, and its temperature lowered.
The cost is no more than that of the common gauze brush. To be had from

THE ELECTRICAL ENGINEERING STORES,

MINORIES. BIRMINGHAM,

OR OF

Bertram Thomas, Cornbrook Telegraph Works, Manchester;
Beanland, Perkin & Co., Prudential Buildings, Park Row, Leeds;
Wm. McGeoch & Co., 108, Argyle Street, Glasgow; and other dealers. 1600

The Brush Complete.

LONDON ROAD IRON WORKS, GLASGOW.

TO STEAM USERS.

ENGINEERS AND BOILER MAKERS.

SUGAR AND TEXTILE MACHINERY MAKERS.

SAVES WATER COAL STEAM SAVES

IF YOUR ENGINES ARE NON-CONDENSING

IF YOUR ENGINES ARE OVERTAXED

IF YOUR BOILERS ARE HARD FIRED

THE THEISEN CONDENSER

CAN BE APPLIED ANYWHERE.

WILL MAKE EASY FIRING.

WILL GIVE POWER EASILY.

WILL SAVE MONEY EVERY HOUR.

WRITE FOR ILLUSTRATED CATALOGUE TO—

LONDON. **D. STEWART & CO., LTD.** GLASGOW.

122, CANNON STREET, E.C.

THE

EDISON & SWAN

UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Head Office, Warehouse, and Showrooms:—

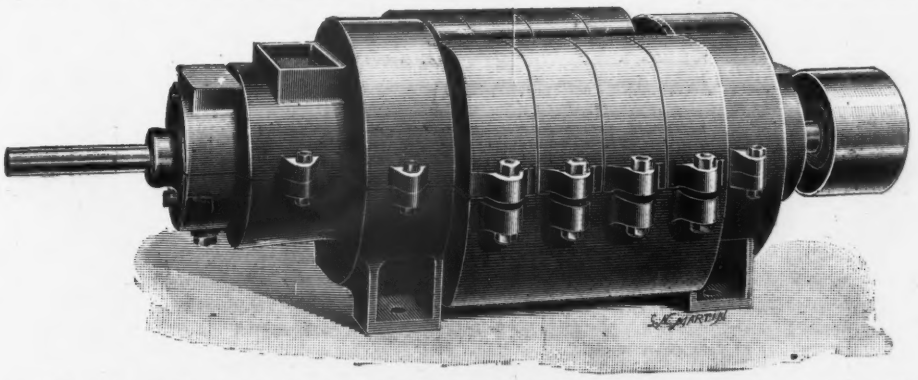
EDISWAN BUILDINGS, QUEEN STREET, LONDON, E.C.

West End Showroom and Warehouse:—50, PARLIAMENT STREET, S.W.

THE EDISWAN ENCLOSED MOTOR

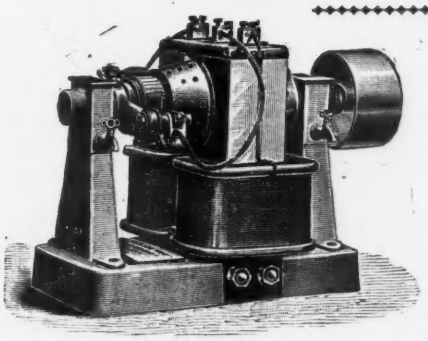
(PATENT),

FOR CONTINUOUS CURRENT.



This machine is entirely Enclosed and proof against atmospheric or other influences, and is made in sizes ranging from ⅛ to 25 B.H.P., is reversible, and runs sparklessly at all loads without any movement of the Brushes; it can also be used as a dynamo. The Bearings are provided with Automatic Continuous Oiling arrangements.

TRADE **EDISWAN** MARK.



TYPE A.

EDISWAN DIAMOND MOTOR.

These motors are of the most recent and improved type, and of the very best workmanship and finish. These machines, although designated as Motors, will run equally well as dynamos, and can be specially wound to run as a 140-volt Dynamo for Charging Accumulators.

EDISWAN TRANSFORMERS.

These Transformers, wound 2,000 to 100, are kept in stock in cases ready for delivery. The primary and secondary coils are of 100% conductivity, double cotton covered copper wire, and insulation is effected by means of a special patented process, which not only affords an excellent and reliable insulation, but renders the transformer waterproof.

ILLUSTRATED PRICE LISTS AND CATALOGUES POST FREE ON APPLICATION.

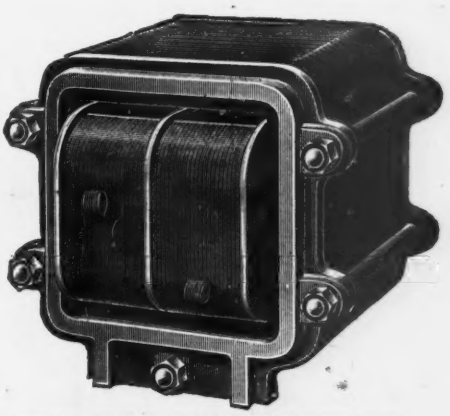


ILLUSTRATION SHOWING TRANSFORMER WITHOUT CASE.

Branches and Agencies throughout the United Kingdom, and in every part of the world.

C

FARADAY & SON'S

ELECTRIC FITTINGS

Dining Room Coronæ
Counter-poise Pendants
Spring Roller Pendants

Drawing Room Sconces
Porch and Loggia Lanterns
Adjustable Standards

2 & 3 BERNERS ST LONDON W 1110

ELECTRICAL INTERLOCKING.

GOLD MEDAL, CRYSTAL PALACE, 1892.

The Board of Trade have again and again urged the necessity of combining the "Lock" and "Block" systems by actual connection between the Telegraph Instruments and Locking Levers, to effect "inter-dependent working." This great improvement, together with Supplementary Automatic Train Action, has been reliably accomplished and brought into practical use on several lines by Messrs. SAXBY & FARMER, under protection of various Patents granted or assigned to them. *Diploma of Honour (the Highest Award), Edinburgh*, 1890. For Particulars, Plans, and Estimates, apply to

SAXBY & FARMER, Ltd., Railway Signal Contractors, Canterbury Road, KILBURN, LONDON, N.W.

Manufacturers of Railway Signals, Cabins, Interlocking Levers, Block Instruments, and Signal Work of every description, Electrical and Mechanical. 1117

ARC LAMPS.

Fig. 1.

BRUSH-VIENNA

Type (fig. 2) for Direct and Alternating Currents. Steady Burning, Self-focussing.

BRUSH ENCLOSED

Type (fig. 1) for Direct Currents. 120 to 150 hours' burning; direct connection to 100/110 volt direct-current circuits.

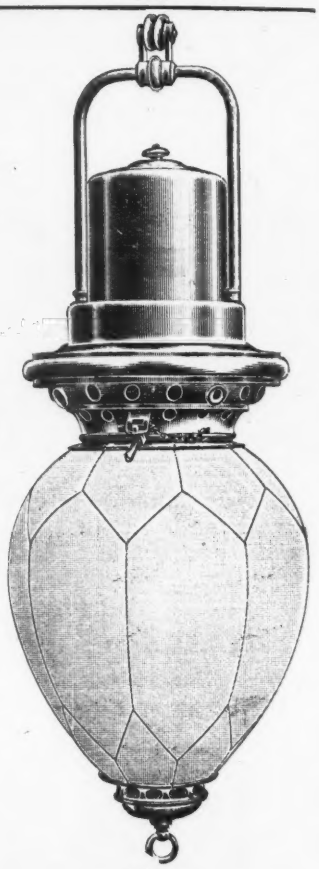


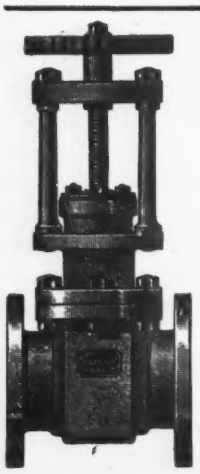
Fig. 2.

SEND FOR LISTS TO

THE BRUSH ELECTRICAL ENGINEERING CO., Ltd.,

49, QUEEN VICTORIA STREET, LONDON, E.C.

6400



BOILER MOUNTINGS AND VALVES for all purposes.

Order "HOPKINSON'S own make."

CATALOGUES POST FREE.

J. HOPKINSON & CO., Ltd., Huddersfield,

Showroom & Depôt:—165, Queen Victoria St., LONDON, E.C.

Telegrams "Hopkinson, Huddersfield"; "Valvestem, London."

E.P.S.

STORAGE BATTERIES

To Her Majesty the Queen.

IN THE UNITED KINGDOM ALONE

400,000 H.P.

AT PRESENT IN USE.

ALL THE ABOVE WERE MANUFACTURED IN ENGLAND.

4, GREAT WINCHESTER ST., LONDON, E.C.

1881

SIEMENS BROTHERS & Co.,

LIMITED.

Electrical and Telegraph Engineers.

MANUFACTURERS OF

India-Rubber, Gutta-Percha and Lead-Covered Cables and Wires for Telegraph, Telephone, and Electric Light Work.

MATERIALS FOR LAND LINES, IRON TELEGRAPH POSTS. INSULATORS INSTRUMENTS. BATTERIES

Electric Mine Exploders, Torpedoes, Torpedo Apparatus,

POLICE, FIRE AND RAILWAY SIGNALS AND BLOCK APPARATUS,

DYNAMOS & ALTERNATORS,

REVERSIBLE MOTORS, TRANSFORMERS,

ARC LAMPS, AMMETERS, VOLTMETERS &c., &c.

ELECTRIC APPARATUS OF ALL KINDS.

CONTRACTORS FOR

SUBMARINE CABLES.

LAND LINES,

SHIP LIGHTING & ELECTRIC LIGHT IN MILLS, FACTORIES, &c.,

ELECTRIC RAILWAYS & TRAMWAYS,

Transmission of Power by Electricity,

CENTRAL STATIONS

SOLE MANUFACTURERS IN ENGLAND OF HELLESEN'S AND OBACH'S DRY BATTERIES.

AGENTS FOR "SIEMENS" GLOW LAMPS & MENEELY TUBULAR BEARINGS.

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Glasgow: 261, WEST GEORGE STREET.
Melbourne: 46 and 48, MARKET STREET.

Works:—WOOLWICH, KENT.

Cable Address: "SIEMENS, LONDON." Codes: A.B.C., A1, Engineering.

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D.P. ACCUMULATORS.

THE D.P. BATTERY COMPANY, Ltd.

Why experiment with the numerous imitations of our well-known Strip Battery when you can have, at the same price, the experience of 7 years' manufacture and use?

AS USED IN COUNTRY HOUSES, &c., THROUGHOUT THE UNITED KINGDOM

AMONG WHICH MAY BE MENTIONED THE FOLLOWING:—

Bank of England,	Birtles Hall,	Callaly Castle,
Metropolitan Police Offices,	Alvaston Hall,	Gilling Castle,
New Scotland Yard,	Chalfont Park,	Prudential Assurance,
Chatsworth,	Caversham Park.	The Dell,
Wynyard Park,	Alnwick Castle,	Stapeley House,
Crewe Hall,	Hoddam Castle,	Shendish,
	Buchanan Castle,	The Rookery.

SOME THOUSANDS SUPPLIED

TO THE **PRINCIPAL ELECTRIC LIGHTING CONTRACTORS,** INCLUDING:—

Messrs. DRAKE & GORHAM,	Messrs. YERITYS, LIMITED,
„ JOHNSON & PHILLIPS,	A. A. CAMPBELL SWINTON, Esq.,
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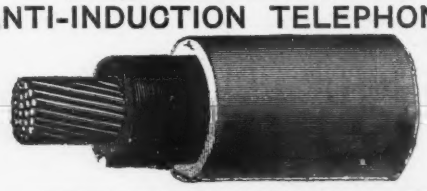

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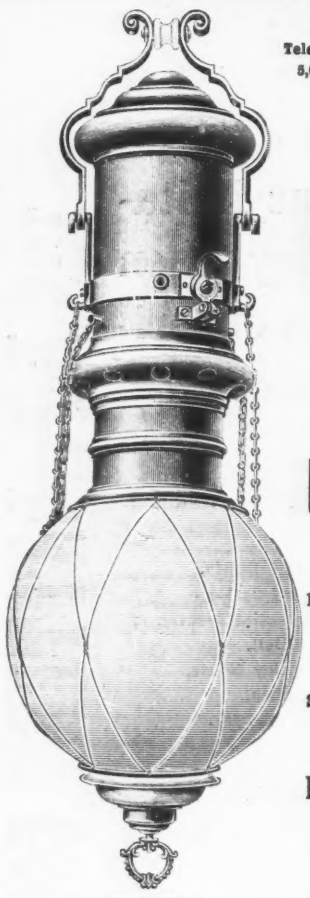

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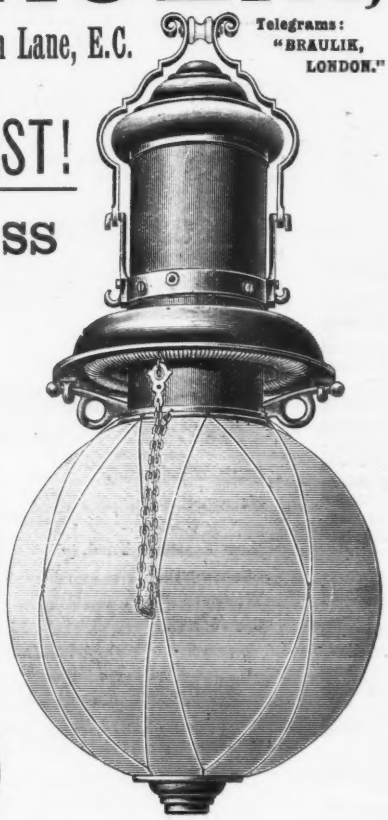

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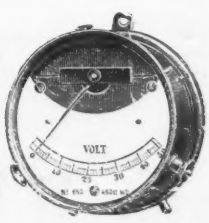

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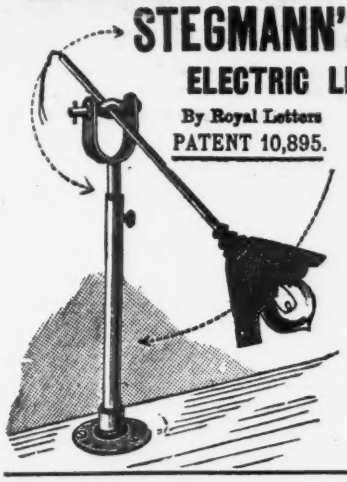

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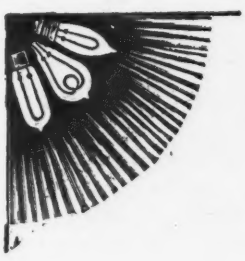

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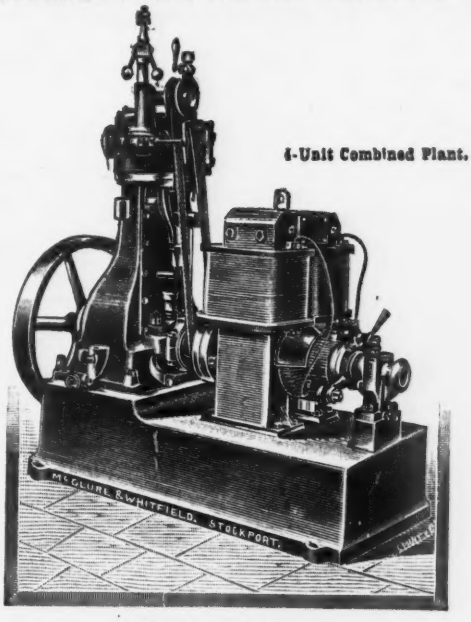

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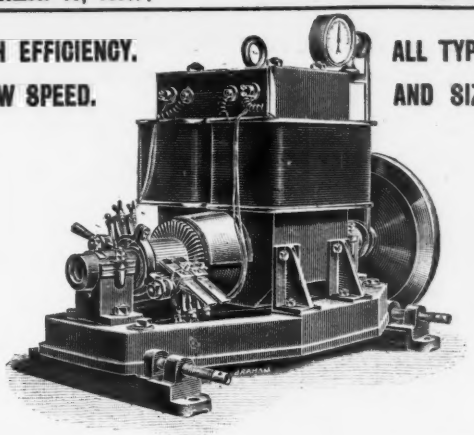

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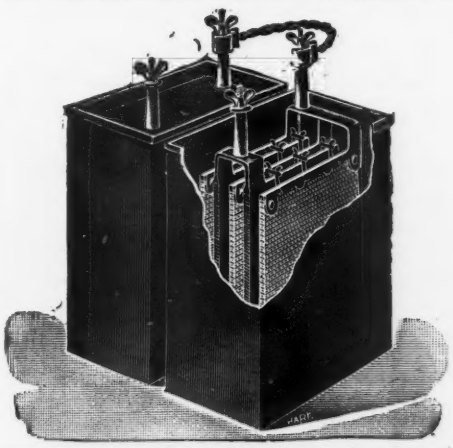

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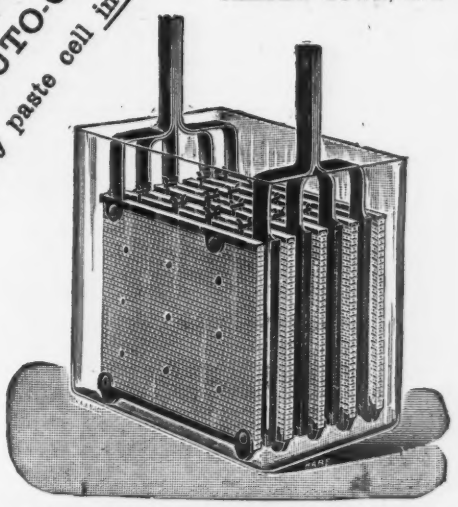

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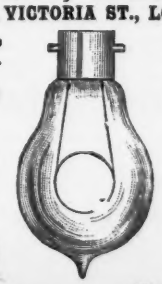

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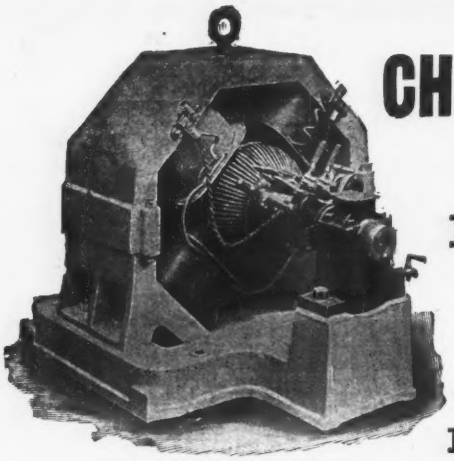

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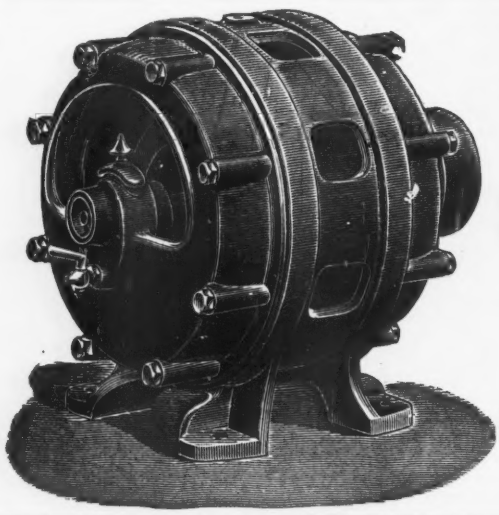

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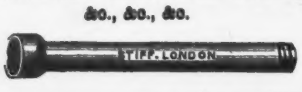

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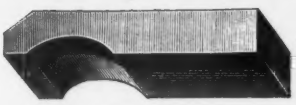

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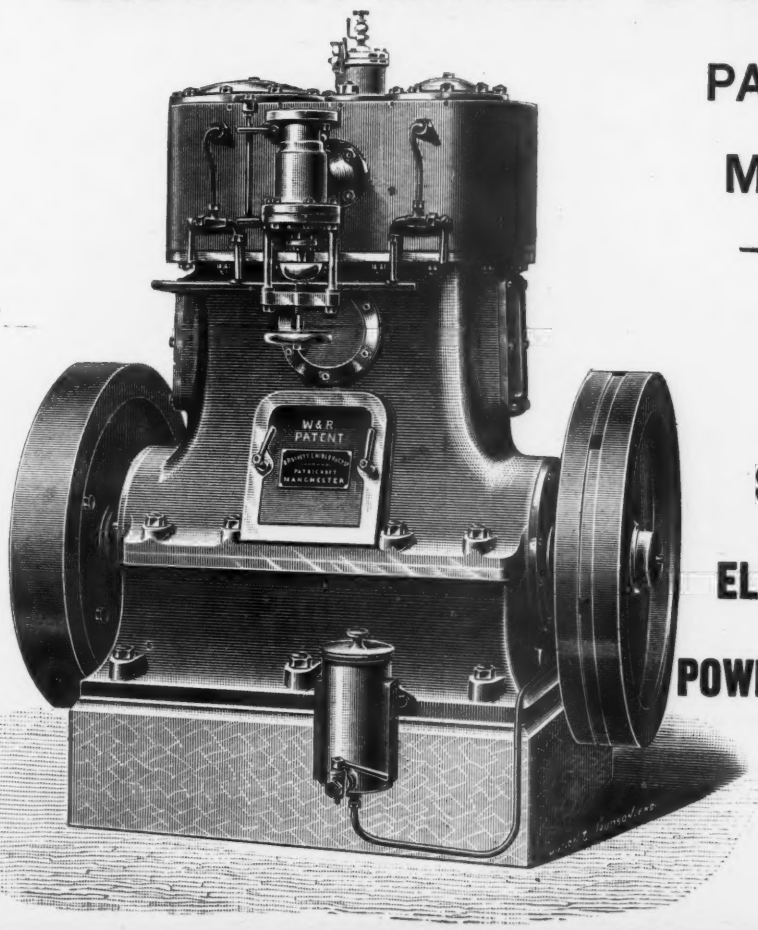

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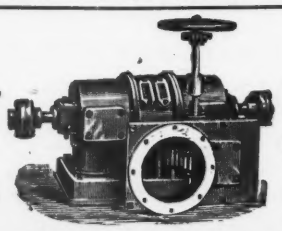

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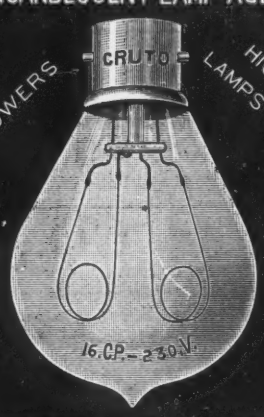

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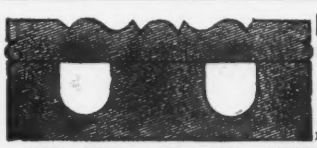

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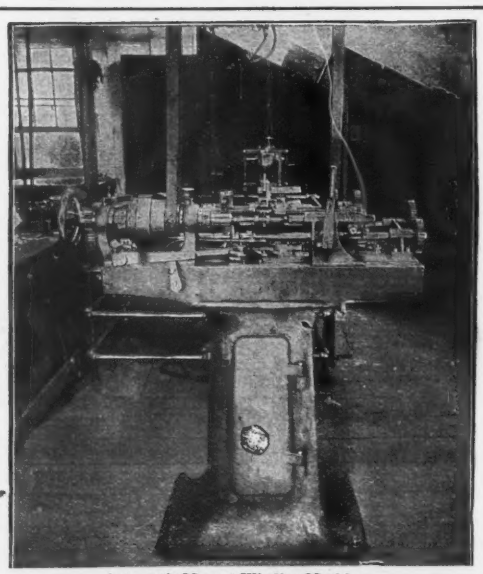

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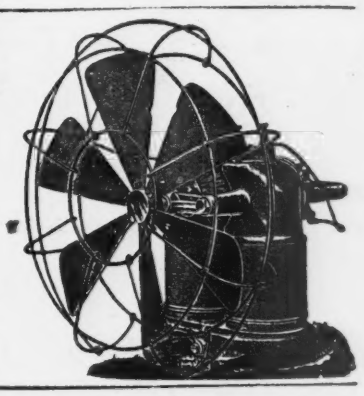

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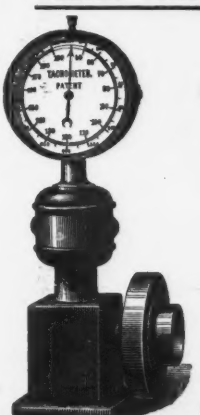

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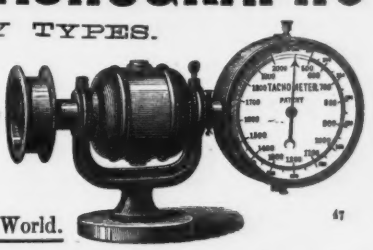

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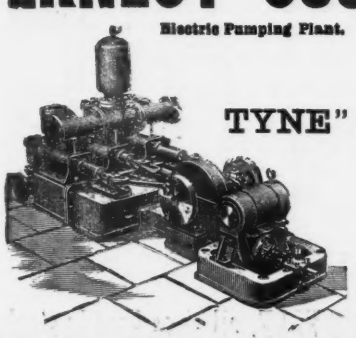

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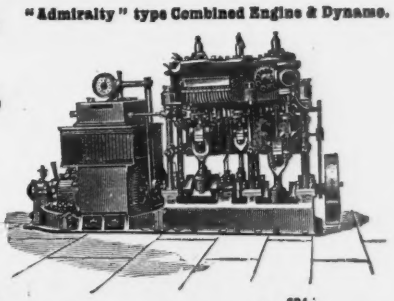

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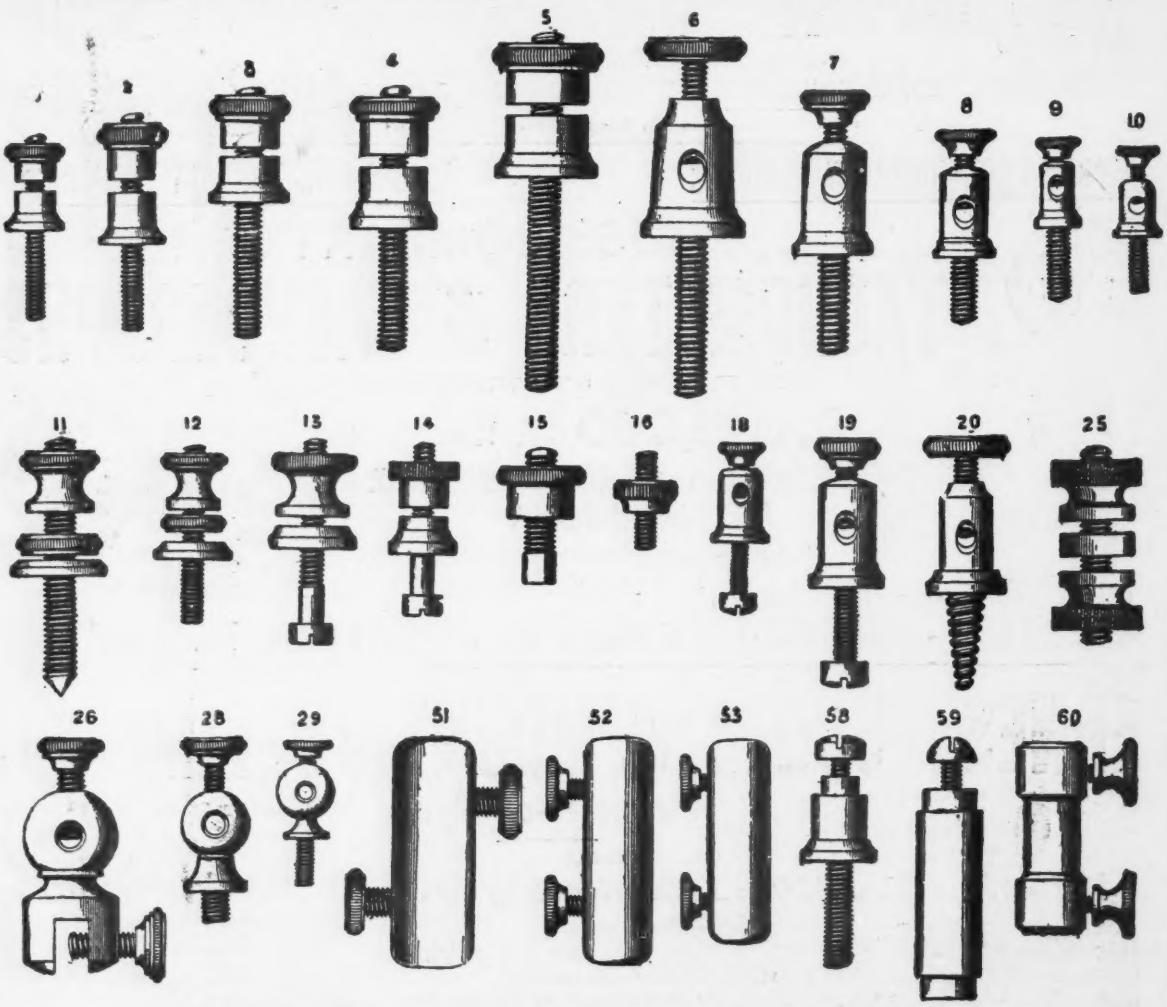

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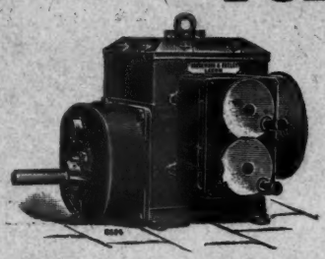

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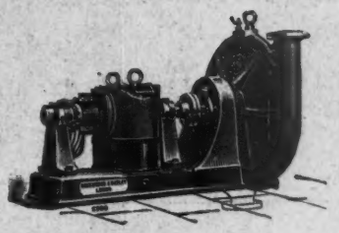

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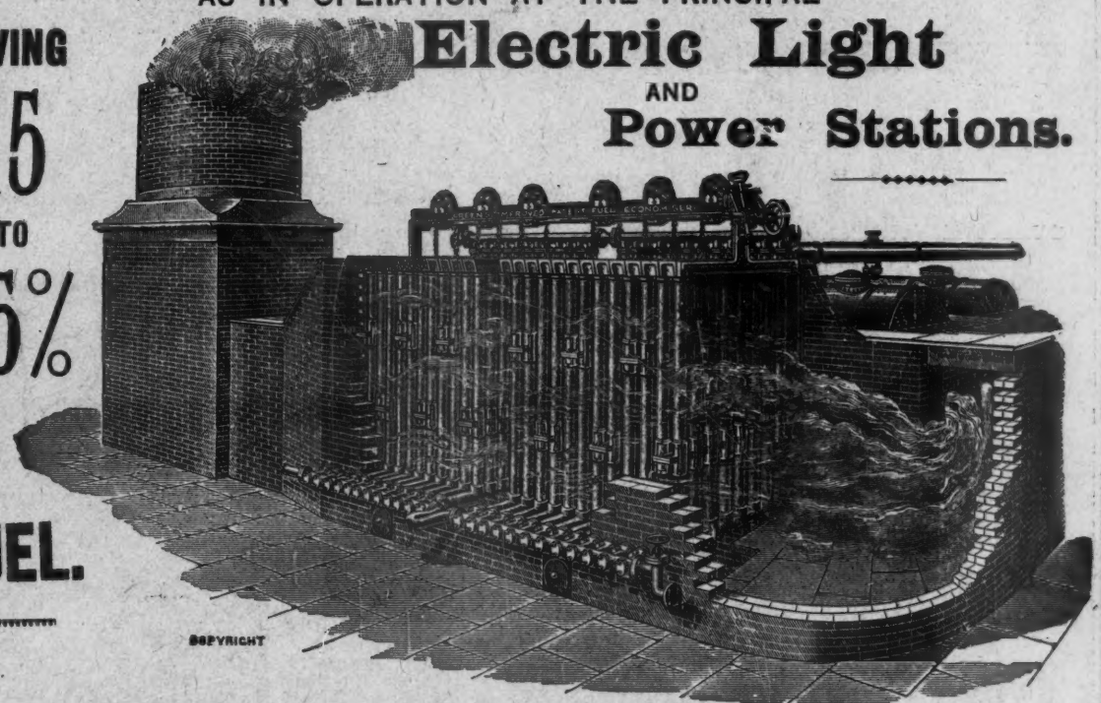

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